SUGARBEET RESEARCH

1980 REPORT

A Report to and for
the Sole Use of Cooperators
NOT FOR PUBLICATION

F O R E W O R D

SUGARBEET RESEARCH is an annual compilation of progress reports concerning incomplete research by Science and Education Administration investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled by Dr. John S. McFarlane, Technical Advisor for sugarbeet breeding. The report has been reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

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Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1980 Report

Section A

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SUMMARY OF ACCOMPLISHMENTS, 1980

VIRUS YELLOWS--Selections for virus yellows resistance and evaluations of varietal reactions were made against only beet western yellows virus (BWYV) again in 1980. Selections were made within 12 breeding lines of which six were open-pollinated, multigerm sources and six were self-fertile sources. Concurrently to the BWYV resistance selections in which foliar color and individual root sugar yield were used as the selection criterion, these populations were inoculated and selected for resistance to erwinia root rot and powdery mildew. Two of the advanced multigerm breeding lines involved in this selection, Y46 and Y41, now appear to possess good levels of resistance to BWYV, erwinia root rot, and powdery mildew. Experimental hybrids with earlier generations (two fewer cycles of selection) of these lines (Y846 and Y841) were consistently ranked toward the top in the 1980 yield trials at Salinas and Brawley. Whereas Y41 needs improvement for curly top and bolting, Y46 has shown good resistance to both. Based upon further testing, these sources of combined disease resistance may be released in the near future to cooperators. Other yellows resistant germplasm was released for increase in 1980. The multigerm breeding line C42 and the monogerm inbred C758 and its CMS counterpart should extend the base of germplasm with multiple disease resistance.

The high incidence of virus yellows and reduced yields in several factory districts of California in 1980 emphasized the continuing need for yellows resistant cultivars in addition to strong beet free and other integrated pest management practices. Test 1580 (pages A30-A31) demonstrates that highly susceptible hybrids grown successfully in other regions sustain major yield reductions when infected with yellows. R. T. Lewellen, I. O. Skoyen, J. S. McFarlane, and E. D. Whitney.

POPULATION IMPROVEMENT--Because sugarbeet cultivars are hybrids, two relative divergent kinds of source populations are needed for extracting heterotic parental lines. For developing pollinators, the populations need to be little different than the traditional multigerm, open-pollinated lines. The sources for the female side of the hybrid, however, have special requirements including the monogerm and type-O characteristics. A portion of the plant breeding research program at Salinas has involved the development of monogerm, type-O source populations that are self-fertile (S^f) and have genetic male-sterile facilitated random mating. The improvement of self-fertile, random mating (S^f-RM) populations for disease resistance, adaption, yield performance, type-O, seed quality, etc., has been an on-going project. The ultimate goal will be to develop high quality monogerm, type-O populations with adequate disease protection so that elite breeding lines extracted from them can be readily used to produce female parental lines. A number of these monogerm, S^f-RM populations were evaluated in variety cross combinations in 1980 at Salinas and Brawley. The results of these tests are presented throughout this report. These populations are identified by the codes 8740, 8741, 8742, 8744, 8745, 8755, 8790, and 8796 in these tests. Several of these populations show promising performance characteristics in variety hybrid combinations. For example, hybrids with 8755 (either with the genetic MS or cytoplasmic MS phase) consistently had better performance than the US H10 and US H11 checks.

At Brawley in essentially a disease free evaluation (Test B280, page A47) the following comparisons were obtained:

Hybrid	Description	Sugar Yield (lbs/A)	Root Yield (T/A)	% Sucrose
US H10	546H3 x C17	10,060	31.3	16.14
E937HL11	8755H0 x C17E2	11,190*	35.0*	16.01 NS
Y931H8	546H3 x C31E2	10,880	32.6	16.77
Y931HL11	8755H0 x C31E2	11,550*	34.7*	16.67 NS

Because the S^f-RM populations depend upon genetic MS ($\underline{a_1a_1}$) and also have CMS counterparts, experimental hybrids with either the $\underline{aa}$ or CMS phases can be readily produced. The results of a series of hybrids with eight S^f-RM populations are presented in Table 880 (page A24). Corresponding hybrids utilizing both $\underline{aa}$ and CMS phases of three S^f-RM populations and two pollinators were evaluated in Test 980 (page A25). The mean sugar yield of the combined $\underline{aa}$ hybrids was significantly better than the CMS hybrids. However, the yields were sufficiently similar and interactions did not occur so that variety hybrids or testcrosses based upon genetic MS should adequately indicate the relative yield of any subsequent CMS development. Also, the CMS phases lag behind in their development and do not represent the most recent improvements in the population as do the $\underline{aa}$ hybrids. Evidence from the 1980 tests suggests that these S^f-RM populations may be excellent germplasm sources for ultimately extracting superior inbred or narrowly bred parental lines.

One of the advantages of the monogerm S^f-RM populations should be the opportunity for simultaneous and parallel improvement with the multigerm populations for disease resistance and performance without always having to "dip" into the multigerm pollinator sources. Thus, a greater genetic diversity can be established and maintained between these sources of parental lines. The results of the tests for evaluating virus yellows (Test 1680, page A32-A33), erwinia root rot, and powdery mildew (Test 2580-1, pages A39-A45) reactions show that these populations are gradually being improved for combined disease resistance. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

EVALUATION OF S_1 FAMILIES--In a continuing program to evaluate the efficacy of S_1 family performance and recurrent selection as a method to improve self-fertile (S^f), monogerm, random-mating populations, 144 S_1 families were evaluated for yield in a simple lattice design in 1980. These S_1 families were from the first cycle synthetic selected for sugar yield. Selected families from these progenies will be recombined to produce the second cycle synthetics. The field performance of these 144 S_1 progenies is summarized in the following table:

Means, ranges, components of variance, and heritabilities for 144 S_1 families from the first cycle synthetic of population 790.

Variable	Mean	Range	Variance Components		H[1/]
			Genetic	Error	
SY (lbs/A)	7,440	3,510 - 10,620	1.4×10^{6}**	6.9×10^{5}	80.4%
RY (T/A)	22.7	10.3 - 34.3	12.2*	7.2	77.4%
% Sucrose	16.4	12.3 - 18.8	0.61 NS	0.43	74.1%
Root Rot (%)	2.6	0.0 - 28.7			
Visual Score	5.0	1.0 - 8.0			
Beets/100'	135	72 - 170			

1/ H (broadsense heritability) = Vg/(Vg + Ve/r), where Vg = total genetic variance and Vg + Ve/r = phenotypic variance.

Simple correlations were run between sugar yield (SY), root yield (RY), and percent sucrose (% S). Correlations were as follows: SY to RY, r = 0.95**; SY to % S, r = 0.18**; RY to % S, r = -0.13*. Although correlations were not calculated, a visual score based on preharvest traits (vigor, uniformity, color, disease reaction, etc.) was associated with sugar yield but exceptions were common enough to prevent visual scores of S_1 families from being a highly reliable selection criterion. Erwinia root rot and powdery mildew, and to a lesser degree virus yellows, rust, downy mildew and spider mites, were contributing influences on the performance of these progeny families. Variability from family to family was observed for all of these factors. R. T. Lewellen and I. O. Skoyen.

POWDERY MILDEW--Powdery mildew was again severe at Salinas in 1980. Even though multiple applications of sulfur were applied to test plots, mildew infection probably caused differential responses in yield performance. The highly susceptible commercial checks US H10 and US H11 consistently had higher incidences of mildew than most experimental hybrids with more moderate levels of susceptibility. Observations in our tests suggested that even moderate levels of resistance to powdery mildew were important in augmenting the control provided by sulfur. We believe that the same would be true in growers' fields and that resistance to powdery mildew should be given a higher priority than it presently receives. In most of the trials at Salinas, US H10 and US H11 type hybrids were ranked last or nearly last and experimental hybrids with moderate degrees of resistance (e.g., those with experimental pollinators Y46, Y41, C31, etc.) were consistently superior and often significantly so for sugar yield per acre. These same experimental hybrids were also usually superior for sucrose concentration compared to US H10 and US H11 type hybrids. Powdery mildew ratings for about 200 breeding lines and hybrids are shown in Tables 2580-1 and 2580-2 (pages A39-A45). Although most breeding lines remain susceptible to moderately susceptible, several promising lines have moderate resistance in combination with resistance to other prevalent diseases. These lines will be made available to breeders if future tests show that they are sufficiently different from existing germplasm. Selection pressure to improve mildew resistance will continue to be exerted against breeding lines

as they are evaluated and selected for other traits. Tests are planned for 1981 to determine what benefit moderate levels of resistance in conjunction with sulfur will have for disease control. R. T. Lewellen and I. O. Skoyen.

ERWINIA ROOT ROT--Breeding for resistance to erwinia root rot was continued in 1980. Selections for resistance were made from both wound-inoculated greenhouse and field plantings. A greenhouse procedure in which plants in the 4- to 6-leaf stage are inoculated appears to be an effective method of selecting for resistance. The reaction of 190 entries was evaluated in two field tests. The results of these tests are summarized in Tests 2580-1 and 2580-2 (pages A39-A45). As previous tests have shown, susceptibility to erwinia root rot is a rather common occurrence among breeding lines and hybrids. It appears in fact that a high level of rot resistance is the exception rather than the rule. Reaction to Erwinia will probably need to be considered before new commercial cultivars are marketed in the Pacific Southwest. C37, an erwinia root rot resistant selection from C17, was released to cooperators for increase in 1980. In Test 2580-2, C37 was as resistant as C36, and had only about one-thirtieth as much soft rot as did C17. R. T. Lewellen, E. D. Whitney, and I. O. Skoyen.

GENETIC ADVANCE FOR YIELD AND DISEASE RESISTANCE IN SUGARBEET--Average sugarbeet yields in California have increased from about 5,000 to 8,000 lbs of sugar per acre from mid-1930's to the present time. This 60% increase in yield can be attributed to both inherent improvements in yielding capacity of cultivars and to changes in cultural practices. To evaluate the approximate genotypic component of this improvement in yield, representative cultivars (R&G Pioneer, R&G Old Type, US 15, US 22/3, US 75, US 56/2, US H6, US H7A, US H10B, and C718H0 x C31E2) were examined in common environments at Brawley and Salinas. Disease trials were made at Salinas only. The results of these tests are summarized in tabular form for Tests 380, 1280, 1880, 1980, 2580-1, and B480. The yield tests at Salinas and Brawley suggested that a significant portion of the yield increase can be attributed to genetic improvement. The improvement in yield has been nearly linear and little evidence was observed of having reached a yield plateau. Whereas sucrose concentration has improved only slightly over the span of the use of the representative cultivars, root yield and sugar yield per acre have significantly increased. The reactions to curly top and virus yellows have been significantly improved, as has nonbolting tendency. Susceptibility to powdery mildew and erwinia root rot can be traced to the primary germplasm sources used to develop the succession of obsolete and modern cultivars. The insights obtained from this study and the comparison of commercial cultivars with experimental hybrids and unadapted cultivars suggest that significant gains can continue to be expected from plant breeding research. I. O. Skoyen, R. T. Lewellen, J. S. McFarlane, and E. D. Whitney.

DIVERGENT SELECTION FOR ROOT TOUGHNESS--Based upon a penetrometer rating, selections were made in three open-pollinated lines for "soft" and "tough" roots. These divergent selections were evaluated in two tests at Salinas in 1980. The results of these tests are presented on pages A53-A56. In comparison with their parental lines, the first cycle selections for low penetrometer values had 4 to 13% lower mean probe values and the high selections had 18 to 22% higher mean probe values. This demonstrated that sufficient genetic variability exists within sugarbeet breeding lines to alter their toughness. I. O. Skoyen and R. T. Lewellen.

FODDER BEET TESTS--In cooperation with other beet research locations, the gross sugar yield of fodder beets was determined in comparison to locally adapted sugarbeet varieties. The results of the Salinas test are included in the Logan summary of the 1980 Uniform Cooperative Trial of European Fodder Beet Varieties. In addition a second fodder beet test was grown at Salinas and is summarized in Test 2480 (page A52). In this trial, the fodder beets ranged from 3.3 to 7.4% sucrose and produced significantly less gross sugar than US H11 even though the root yield of most of the fodder beet entries was nearly twice as large. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

GERMPLASM PRESERVATION--Greenhouse and field increases were made of 30 wild Beta species and of 25 obsolete varieties and breeding lines. Seed samples of many of these increases are being placed in the National Seed Storage Laboratory at Fort Collins. During a trip to Europe in May 1980 arrangements were made to obtain additional seed samples of wild Beta species from Poland and England. Seed increases of these introductions will be made in 1981. Work is underway to describe and catalog the wide range of Beta introductions that we have accumulated over the years. J. S. McFarlane.

FUSARIUM STALK BLIGHT RESISTANCE--A five year study of Fusarium stalk blight resistance was completed at Salem, Oregon in 1980. The C566 selection from the widely used C563 inbred again showed very good resistance. Other selections with good resistance were 9536-4 and 9505-32. Results with F_1 hybrids, backcrosses, and F_2 segregating populations show that resistance is dominant. No definite conclusions could be drawn regarding inheritance. At least two genes are involved. Susceptibility is either not linked to the monogerm character or linkage is very loose. Seeds of both C566 and C566 CMS have been distributed to breeders. A second backcross of the CMS to C566 is being made in 1980-81. The resulting CMS line is expected to be similar to C566 in stalk blight resistance and other characters. Detailed results of the 1980 stalk blight tests are given on pages A57-A61. J. S. McFarlane.

TRANSMISSION OF NEMATODE RESISTANCE OF HOMOZYGOUS RESISTANT SUGARBEETS AND THEIR PROGENIES--The recovering frequency of homozygous resistant plants from crosses of resistant heterozygotes was about 1.1%. Plants of these true-breeding families transmitted resistance to 98.4% of their progeny, with the remainder moderately resistant. However, resistant heterozygotes derived from outcrosses of these resistant homozygotes transmitted resistance to less than 50%, instead of 75%, of their selfed progeny. This suggests that resistant homozygotes as female parents gave full transmission of nematode resistance, but their outcrossed resistant descendant acquired little enhancement in rate of transmission of resistance. M. H. Yu.

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1980

ESAU, K. and L. L. HOEFERT. Endoplasmic reticulum and its relation to microtubules in sieve elements of sugarbeet and spinach. J. Ultrastruct. Res. 71:249-257. 1980.

The structure of the food-conducting cell of plants--the sieve element--is of utmost importance to physiological, structural, and pathological studies of plants. The present report describes tubules in developing sieve elements of sugarbeet and spinach and depicts the interrelationships of the tubules, cellular endoplasmic reticulum, and cellular microtubules. The work contributes to our knowledge of the fundamental structural variations in sieve elements of sugarbeet and spinach.

HILLS, F. J., W. H. LANGE, R. J. SHEPHERD, and J. S. McFARLANE. Sugarbeet pest management: Control of aphid-borne viruses. Univ. of California Bull. (In press). 1981.

Yellowing viruses were a major cause of poor sugarbeet yields during the 1950's and 1960's. With the adoption of appropriate control measures, yields have increased by about 20%. These control measures include beet-free periods, development and use of a moderately resistant variety, and the protection of young plants by timed application of effective aphicides.

LEWELLEN, R. T. Sugarbeet diseases, in Parker, S. P., (Ed.), McGraw-Hill Encyclopedia of Science and Technology 5th Edition, McGraw-Hill, N.Y. (In press). 1981.

This is a section of an article on sugarbeet that will be included in the 5th edition of the McGraw-Hill Encyclopedia of Science and Technology.

STEELE, A. E. Invasion of sugarbeet leaf blades by larvae of Heterodera schachtii. J. Nematol. 13:91-92. 1981.

Under experimental conditions newly hatched larvae of the sugarbeet nematode, Heterodera schachtii Schm. invaded leaf blades of sugarbeet, Beta vulgaris L. cultivar US 75. Single leaves of only 2 of 6 plants inoculated were invaded.

STEELE, A. E. and HELEN SAVITSKY. Resistance of trisomic and diploid hybrids of Beta vulgaris and B. procumbens to the sugarbeet nematode, Heterodera schachtii. J. Nematol. (In press). 1981.

Trisomic and diploid hybrids of sugarbeet, Beta vulgaris L., and wild beet, B. procumbens Chr. Sm. have the gene for resistance to Heterodera schachtii Schm. transferred from B. procumbens. Although not absolute, the hybrids were highly resistant to H. schachtii. Resistance in these hybrids is not due to failure of larvae to enter roots, but is due to failure of larvae to reach maturity. Although significantly greater numbers of female nematodes developed on plants inoculated with populations from The Netherlands or Italy than on plants inoculated with a population collected from the Salinas Valley of California the totals for all populations on resistant plants were extremely small. Greater numbers of males than females developed on root slice cultures of resistant hybrids.

THOMSON, S. V., F. J. HILLS, E. D. WHITNEY, and M. N. SCHROTH. Sugar and root yield of sugarbeet as affected by vascular necrosis and rot, nitrogen fertilization and plant spacing. Phytopathology (In press). 1981.

Cultivar, spacing of plants, and nitrogen nutrition affected losses due to bacterial vascular necrosis and rot of sugarbeet. Wide spaced plants and plants grown under high nitrogen levels were more susceptible to infection and rot than plants spaced or fertilized at the recommended level. The resistant cultivar was affected less by wide spacing between beets than susceptible ones. These data should aid growers in selecting practices that will minimize losses due to bacterial rot.

WHITNEY, E. D. and N. F. MANN. Effect of resistance on growth of Cercospora beticola race C2 on the leaf surface and within sugarbeet leaf tissue. Phytopathology (In press). 1981.

When sugarbeet cultivar FC 701/2 was inoculated with Cercospora beticola, race C2, the host responded with a susceptible reaction, a large fleck reaction, a small fleck reaction, or no visible reaction. These symptoms were consistent from one inoculation to another and within a single host plant. The pathogen on resistant plants exhibited a reduction in number of germtubes per conidium, width of mycelium, and appressorium length, and a change in appressorium configuration, in comparison to the pathogen on the susceptible plants. We interpret these changes in the pathogen as a fungal cell or tissue response to the resistance of the plants rather than as an environmental effect.

YU, M. H. and A. E. STEELE. Host-parasite interaction of resistant sugarbeet and Heterodera schachtii. J. Nematol. 13: (In press). April 1981.

The host-parasite relationships between Heterodera schachtii and the nematode-resistant sugarbeets were examined. Second-stage larvae penetrated sugarbeet roots and migrated up to 1.95 mm before establishing permanent feeding sites. Most sedentary larvae were oriented parallel to the root axis or in various diagonal or fold positions in the cortex. Nematodes adopted no definite orientation with regard to the root apex. Nematode feeding stimulated formation of multinucleate syncytia in host tissues. Syncytia were 0.3-1.1 mm in length, up to 90 µm x 150 µm in cross section. Root diameters were enlarged close to feeding sites. Most nematodes did not develop to maturity in the resistant host tissues. Usually nematodes deteriorated concomitant with necrosis of syncytia, and dead nematodes frequently appeared macerated or flattened and deformed. Cavities left by collapse of syncytia were filled by growth of parenchymatous tissue.

BOLTING AND VARIETY TRIALS, SALINAS, CALIFORNIA, 1979-80

Location: USDA-SEA Agricultural Research Station

Soil type: Sandy loam (Chualar series)

Previous crops: 1979-80 Sugarbeet test areas, Spence Field:
Block 5 - south 16 acres, fallow 1976-1980; sugarbeet trials, 1975 on north 6 acres, and 1976 on south 10 acres.
Block 6 - south 6.7 acres, fallow 1976-1980, sugarbeet trials, 1975.

Fertilizer used: Preplant: Dolomite (equivalent to 105% $CaCO_3$),was broadcast on Block 6 at a rate of 980 lbs/A and disced in about 6" deep. All tests in Block 5 had 346 lbs/A 5:20:10 applied broadcast and chiseled in before listing in October 1979. All tests in Block 6 received the same preplant treatment before listing in April 1980. Prior to seeding, 250-320 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band on the beds.

Supplemental nitrogen: Two to four applications, as sidedressed ammonium sulfate or by sprinkler irrigation system as 32% nitrogen in a liquid formulation.

Total fertilization (lbs/A):

N	P_2O_5	K_2O
283	69	34

Summary: 1979-80 Tests at Salinas (Spence Field):

Test No.	Sowing Date 1979-1980	Thinning Date 1980	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1980	Test Design
180	11/21	1/7-22	119	2	1	30	--	RCB
280	11/21	"	186	2	1	30	--	RCB
380	11/21	"	16	4	1	30	--	RCB
480	11/22	"	16	8	2	30	9/16-18	RCB
580	11/22	"	20	4	1	30	11/18-21	RCB
680	1/25	2/29	16	8	2	30	9/21-22	RCB
780	1/25	thru	16	8	2	30	9/23-25	RCB
880	1/25	3/11	16	8	2	30	9/29-30	RCB
980	1/26	"	16	8	2	30	10/1-2	RCB
1080	1/26	"	8	8	2	30	10/2	RCB
1180	1/26	"	8	8	2	30	10/6	RCB
1280	1/28	"	16	8	2	30	10/8-9	RCB
1380	2/1	"	4	4	4	58	9/25-26	Split-block
1480	4/2	5/1-8	8	8	2	30	10/27-28	"
1580	4/2	"	8	8	1	30	10/20	"

Test No.	Sowing Date 1979-1980	Thinning Date 1980	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1980	Test Design
1680	4/2	5/1-8	8	8	1	30	10/21	Split-block
1780	4/3	"	20	8	1	30	10/21-23	"
1880	4/3	"	8	8	1	30	10/9-10	"
1980	4/8	"	16	8	2	30	10/14-15	RCB
2080	4/8	"	16	8	2	30	10/15-16	RCB
2180	4/8	"	20	4	1	30	10/6	RCB
2280	4/9	"	144	2	1	20	10/28-29	12x12 SL
2380	4/9	"	16	6	4	20	10/7-8	RCB
2480	4/9	"	12	4	2	20	10/2	RCB
2580-1	4/30	5/28	20	4	1	24	10/28-31	RCB
2580-2	4/30	"	171	1,2 or 4	1	24	10/28-31	RCB

Inoculation dates (1980): Tests 1480 through 1880: June 5 with BWYV.
Tests 2580-1 and 2580-2: July 16, 1980, with a suspension of Erwinia isolates.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide use: Pyramin W, at rates of approximately 4 lbs/A, was sprayed post plant and watered in with 1/2 to 3/4 inch sprinkler irrigation.

Diseases and insects: Natural virus yellows infection was moderately light throughout tests seeded between November 21, 1979 and April 30, 1980 (Tests 180 through 2480, Field 1, and Tests 2580-1 and -2, Field 2).

Inoculated BWYV Tests 1480 through 1880 were sprayed with 2.4 pints/A Meta Systox R on June 7, 1980 for control of BWYV vector.

All Tests, inoculated and non-inoculated, were sprayed with Meta Systox R for aphid control on: May 21, 1980: Tests 1980-2480 with 2.3 pints/A. July 1, 1980: Tests 180-2480 with 3 pints/A.

Powdery mildew infection was moderately severe in 1980 where it was not controlled and appeared first (mid-June) in the earliest seeded tests. The degree of control, with the application of sulfur appeared to be less in 1980 than that observed in previous years. One to four spray applications of wettable sulfur at rates of 9 to 13 lbs/A, on designated test areas, were made on June 24, July 7 and 15, August 11, 14 and 24, and September 9, 1980. Some differential responses in yield probably occurred due to PM infection.

Downy mildew infection was not a significant disease problem in 1980.

Natural infection of Erwinia soft rot was moderately light in susceptible lines and had minimum effect on yield in 1980.

Sugarbeet nematode infestation was light to moderate in Block 5, Tests 180 through 2480. Infestation appeared to be fairly uniform with most cysts developing late in the season.

Sugar analysis: Determined from two samples per plot of approximately 10 roots each or 25-40 lbs of roots at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: Nitrogen application rates were unusually high again in 1980 tests because of slow growth and an unthrifty appearance during the growing season. The cause was probably due to a compacted soil condition we were unable to correct. This resulted in poor water penetration.

Test results should be reliable but not as good as most years.

The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

TEST 280. BOLTING EVALUATION TEST,
SALINAS, CALIFORNIA, 1979-80

186 entries with 2 replications
1-row plots, 30 ft. long — Planted: November 21, 1979

Variety	Description	Stand Count	Bolting 8/13	Bolting 11/4
		No.	%	%
HYBRIDS				
464H8 (US H7A)	546H3 x F66-64	85	2.4	5.9
964H8 "	" x 364 (C64)	75	8.0	8.0
US H10B	546H3 x C17 (6169)	83	6.0	7.2
E637H8	546H3 x E537	86	1.2	2.3
E837H8	" x E737	81	8.6	9.9
E937H8	" x E837	81	3.7	3.7
717H8 (US H10B)	" x 417 (C17)	80	2.5	3.8
917H8 "	" x 417 (C17)	84	2.4	3.6
US H11	546H3 x C36 (78016)	82	0.0	0.0
US H11	" x C36 (Amer. Cry.)	81	2.5	2.5
SSE1	Sprex. F77-36 hybrid	86	1.2	1.2
E736H8 (US H11)	546H3 x E536 (C36)	93	2.2	3.2
E936H8 "	" x E736 (C36)	89	6.7	10.1
8717H8	" x 7717	85	5.9	7.1
8719H8	" x 6719	91	7.7	8.8
Monatunno	Hilleshog (K19307)	84	2.4	3.6
MonoHy D2	GW hybrid	86	54.7	54.7
HH27	Holly hybrid	77	67.5	72.7
1443	Beta Seed	78	44.9	50.0
Hh Mono 545	NB Hilleshog (87386)	75	0.0	1.3
968H8	546H3 x 468	82	4.9	7.3
Y823H8	" x Y723	78	7.7	15.4
915H8	" x 915	82	4.9	4.9
Y826H8	" x Y726	87	10.3	13.8
959H8	" x 959	87	16.1	17.2
Y905H8	" x 68-9163	88	38.6	42.0
Y731H8	" x Y631E (C31E1)	77	0.0	1.3
Y931H8	" x Y831E (C31E2)	86	8.1	11.6
Y939H8	" x Y839	95	14.7	16.8
Y740H8	" x Y640	82	8.5	9.8
Y940H8	" x Y840	79	11.4	11.4
Y741H8	" x Y641	83	12.0	12.0
Y941H8	" x Y841	86	19.8	20.9
Y942H8	" x Y842	78	9.0	9.0
Y746H8	" x Y646	85	0.0	0.0
Y946H8	" x Y846	93	3.2	3.2
Y947H8	" x Y847Rr	87	4.6	5.7
Y948H8	" x Y848Rr	84	7.1	10.7

TEST 280. BOLTING EVALUATION TEST,
SALINAS, CALIFORNIA, 1979-80

Variety	Description	Stand Count	Bolting 8/13	Bolting 11/4
		No.	%	%
Y931H3	F66-562HO x Y831E (C31E2)	86	5.8	9.3
Y931H26	C779HO x Y831E	84	1.2	1.2
E937H17	5551H5 x E837 (C17E2)	83	8.4	14.5
Y931H17	5551H5 x Y831E	88	5.7	5.7
Y941H17	5551H5 x Y841	78	26.9	26.9
E937H24	7522H21 x E837	85	0.0	0.0
Y931H24	7522H21 x Y831E	77	2.6	2.6
Y941H24	7522H21 x Y841	89	7.9	7.9
Y942H24	7522H21 x Y842	74	6.8	6.8
E937H25	7522H4 x E837	84	6.0	7.1
964H72	F74-718HO x 364	76	6.6	7.9
E936H72	" x E736 (C36)	77	5.2	7.8
E937H72	" x E837	82	1.2	2.4
Y731H72	3718HOB x Y631E (C31E1)	79	0.0	1.3
Y931H72	F74-718HO x Y831E (C31E2)	80	7.5	10.0
Y940H72	" x Y840	84	19.0	21.4
Y941H72	" x Y841	79	26.6	30.4
Y946H72	" x Y846	82	9.8	12.2
E937HL11	8755HO x E837	85	14.1	15.3
Y931HL11	8755HO x Y831E	83	2.4	2.4
E937HL24	8755aa x E837	85	4.7	7.1
Y931HL24	8755aa x Y831E	81	13.6	14.8
Y931HL1	7758-1H2 x Y831E	93	2.2	3.2
Y931HL2	7758-3H2 x Y831E	93	4.3	7.5
Y931HL6	8740HO x Y831E	86	5.8	8.1
Y931HL7	8741HO x Y831E	83	2.4	4.8
Y931HL8	8742HO x Y831E	77	10.4	11.7
Y931HL9	8744HO x Y831E	78	3.8	6.4
E937HL9	8744HO x E837	84	2.4	3.6
Y931HL10	8745HO x Y831E	83	2.4	2.4
E937HL10	8745HO x E837	79	8.9	10.1
Y931HL13	7790HO x Y831E	71	7.0	8.5
Y931HL14	7796-1HO x Y831E	66	16.7	18.2
Y931HL15	7796-2HO x Y831E	75	12.0	12.0
OPEN-POLLINATED				
417	Inc. 813A (C17)	53	7.5	7.5
717	Inc. 417 (C17)	59	6.8	8.5
917	Inc. 417 (C17)	76	6.6	6.6
E637	Inc. E537 (C17E1)	60	5.0	5.0
E837	Inc. E737 (C17E2)	74	9.5	9.5
E937	Inc. E837 (")	72	6.9	6.9
E937	YR-ER E737 (C37)	68	1.5	1.5
E840	Inc. E640	55	10.9	25.5

TEST 280. BOLTING EVALUATION TEST,
SALINAS, CALIFORNIA, 1979-80

Variety	Description	Stand Count	Bolting 8/13	Bolting 11/4
		No.	%	%
F70-13	Inc. F66-13 (C13)	71	25.4	25.4
813	Inc. 413C (C13)	82	4.9	6.1
F77-36	Inc. C36 (7322)	78	10.3	11.5
F78-36	Inc. F77-36 (78087)	76	5.3	6.6
F79-36	Inc. C36 (79377)	76	5.3	5.3
E736	Inc. E536 (C36)	63	6.3	9.5
E936	Inc. E736 (C36)	67	14.9	14.9
E936	NB E736	77	0.0	0.0
F79-31	Inc. C31E2 (79427)	79	2.5	3.8
Y831E	YRS Y631E	78	2.6	2.6
Y931	Inc. Y831E (C31E2)	69	2.9	7.2
Y931E	YR-ER Y631E	84	2.4	2.4
Y731	Inc. Y631E (C31E1)	81	2.5	3.7
Y939	Inc. Y839	77	24.7	24.7
Y740	Inc. Y640	81	22.2	23.5
Y940	Inc. Y840	77	18.2	18.2
Y741	Inc. Y641	74	25.7	27.0
Y941	Inc. Y841	75	53.3	60.0
Y746	Inc. Y646	87	1.1	1.1
Y946	Inc. Y846	91	6.6	7.7
Y942	Inc. Y842	71	21.1	22.5
Y947	Inc. Y847Rr	83	16.9	18.1
Y948	Inc. Y848Rr	88	17.0	19.3
US 22/3	Logan	89	93.3	93.3
Y905	Inc. 68-9163 (R&G Pioneer)	88	47.7	60.2
915	Inc. 915 (US 15)	77	19.5	20.8
Y823	Inc. Y723	73	27.4	31.5
Y923	YR-ER Y723	92	42.4	42.4
959	Inc. 959 (US 56/2)	80	16.3	18.8
Y826	Inc. Y726	86	48.8	48.8
Y926	YR-ER Y726	92	31.5	37.0
468	Inc. 868 (US 75)	79	5.1	5.1
968	Inc. 468 (")	78	10.3	11.5
Y930	YR-ER Y730	79	20.3	21.5
964	Inc. 364 (C64)	81	2.5	4.9
8270	Inc. K2-2n	76	11.8	15.8
8271	Inc. K2-4n	69	8.7	14.5
8273	Inc. MP10-4n	76	50.0	59.2

TEST 280. BOLTING EVALUATION TEST,
SALINAS, CALIFORNIA, 1979-80

Variety	Description	Stand Count	Bolting 8/13	Bolting 11/4
		No.	%	%
SELF-FERTILE, RANDOM MATING				
8740	7740Baa x A	77	13.0	19.5
9740	YR-ER 7740B (A,aa)	79	7.6	7.6
8741	7741Baa x A	64	4.7	9.4
9741	YR-ER 7741B (A,aa)	74	4.1	5.4
8742	7742aa x A	75	28.0	33.3
9742	YR-ER 7742 (A,aa)	85	18.8	20.0
8744	7744aa x A	58	8.6	8.6
9744	YR-ER 7744 (A,aa)	70	11.4	12.9
8745	7745aa x A	71	4.2	5.6
9745	YR-ER 7745 (A,aa)	77	0.0	1.3
9746	8746aa x A	84	27.4	28.6
9746HO	8742HO x 8746	92	29.3	32.6
7755	6755aa x A	87	14.9	17.2
8755	7755Baa x A	79	7.6	7.6
8755HO	7755HO x 7755B	77	28.6	32.5
9755	YR-ER 7755B (A,aa)	86	16.3	17.4
7789	6789aa x A	81	13.6	14.8
9789	8789aa x A	87	1.1	3.4
7790	6790aa x A	78	17.9	19.2
9790	8790aa x A	78	3.8	10.3
9790D	T-O-Sel. 8790Daa x A	83	8.4	8.4
9790DHO	7790DHO x T-O-Sel. 8790D	87	12.6	14.9
7796-1	6796-1aa x A	86	15.1	18.6
9796-1	8796-1aa x A	86	8.1	9.3
9796-1HO	7796-1HO x 8796-1	85	4.7	7.1
7796-2	6796-2aa x A	79	17.7	24.1
9796-2	8796-2aa x A	85	7.1	7.1
9796-2HO	7796-2HO x 8796-2	82	17.1	17.1
F_1 HYBRIDS & INBREDS				
F70-546H3	562HO x 546	83	4.8	10.8
F78-546H3	562HO x 546 (78155)	84	3.6	6.0
9718H3	F66-562HO x 3718 (C718)	96	2.1	2.1
9718H26	C779HO x 3718	93	1.1	4.3
9718HL9	8744HO x 3718	87	1.1	3.4
9718HL11	8755HO x 3718	85	10.6	12.9
8779H3	F66-562HO x 7779 (C779)	85	9.4	16.5
8779H72	F74-718HO x 7779	91	8.8	11.0

TEST 280. BOLTING EVALUATION TEST,
SALINAS, CALIFORNIA, 1979-80

Variety	Description	Stand Count	Bolting 8/13	Bolting 11/4
		No.	%	%
8536H72	F74-718HO x F75-536	97	1.0	1.0
8536	Inc. F75-536 (78298)	87	0.0	1.1
F78-546	Inc. F70-546 (78156)	65	9.2	9.2
9546E	ER-YR 7546E	86	5.8	5.8
9767E-1	ER-YR 9563E	80	1.3	2.5
9767E-2	ER-YR 9563EHO	65	4.6	4.6
7758-3	Inc. 6758-3	82	1.2	2.4
7758-3H2	6758-3H72 x 6758-3	86	3.5	5.8
F74-718	Inc. C3718 (4170)	79	27.8	32.9
F74-718HO	C3718HO x C3718 (4169)	84	14.3	16.7
9718	Inc. 3718 (C718)	82	2.4	2.4
9718HO	C718HO (Iso.) x 3718	88	1.1	1.1
9758-1	ER-YR 6758-1 (C758)	73	0.0	0.0
9758-1HO	7758-1H2 x ER-YR 6758-1	86	1.2	1.2
7758-1	Inc. 6758-1	77	0.0	0.0
7758-1H2	6758-1H72 x 6758-1	88	2.3	2.3
8779	Inc. 7779 (C779)	58	1.7	3.4
8779HO	7779HO x 7779 (C779CMS)	87	9.2	10.3
F79-779	Inc. C779 (79435)	96	3.1	6.3
F79-779HO	C779CMS x C779 (79434)	90	0.0	1.1
F66-562	Lot 6618	75	24.0	28.0
F66-562HO	Lot 6349	78	17.9	21.8
F67-563	Lot 7433	73	30.1	35.6
F67-563HO	Lot 7432	77	6.5	9.1
8717	Inc. 7717	74	2.7	4.1
8719	Inc. 6719	77	0.0	0.0
9720C1	YR-ER 7207-12, 14, 32, 43⊗	71	1.4	2.8
9723C1	YR-ER 7203-#'s ⊗	72	4.2	8.3
8215C1	7205 (bmbm)⊗, (S_2B_5 $C17S^f$)	38	0.0	0.0
8217C1	7207 (bmbm)⊗, (S_3B_4 $C17S^f$)	36	22.2	22.2
8211C1	7201 (bmbm)⊗, (S_2B_5 $C01S^f$)	38	13.2	18.4
8213C1	7203 (bmbm)⊗, (S_3B_4 $C01S^f$)	40	2.5	2.5

TEST 380. BOLTING EVALUATION OF CALIFORNIA CULTIVARS, SALINAS, CALIFORNIA, 1979-80

16 entries x 4 replications, RCB
1-row plots, 30 ft. long

Planted: November 21, 1979

Variety	Description	Stand Count	Bolting 6/25	Bolting 8/13	Bolting 10/28
		No.	%	%	%
US 22/3	Logan	147	89.8	94.6	98.6
Y905	Inc. 68-9163 (R&G Pioneer)	169	46.7	68.6	71.0
915	Inc. 915 (US 15)	165	0.6	7.3	9.1
959	Inc. 959 (US 56/2)	151	6.0	16.6	19.2
968	Inc. 468 (US 75)	167	4.2	10.2	10.8
964H2 (US H6)	4547H1 x 364	172	0.6	3.5	7.0
964H8 (US H7A)	546H3 x 364	169	0.0	3.0	3.0
917H8 (US H10B)	" x 417	172	0.0	4.1	5.2
E936H8 (US H11)	" x E736	173	0.0	3.5	3.5
Y931H8	" x Y831E	161	0.0	6.2	6.2
E937H8	" x E837	166	0.0	6.0	9.6
F78-546H3	562HO x 546 (78155)	172	1.2	2.9	4.7
E937	Inc. E837 (C17E2)	164	1.8	5.5	6.1
917	Inc. 417 (C17)	161	1.9	8.7	11.8
Y931	Inc. Y831E (C31E2)	159	2.5	3.8	4.4
E936	Inc. E736 (C36)	169	4.1	7.1	7.1
	BOLTING SELECTION PLOTS, 1980				
Y923	YR-ER Y723	618	19.4	50.8	55.5
Y926	YR-ER Y726	655	15.6	49.0	52.2
9744	YR-ER 7744	650	2.8	8.9	10.3
9745	YR-ER 7745	702	0.6	3.6	4.1
9755	YR-ER 7755B	1005	5.8	20.1	22.2
8211C1	7201(bmbm)⊗, S_2B_5 C01S^f	504	2.4	9.9	11.9
8213C1	7203(bmbm)⊗, S_3B_4 C01S^f	425	0.2	5.2	8.0
8215C1	7205(bmbm)⊗, S_2B_5 C17S^f	314	1.6	7.0	8.6
8217C1	7207(bmbm)⊗, S_3B_4 C17S^f	343	30.3	39.7	44.0
Y947	Inc. Y847Rr	660	6.7	28.8	29.5
Y948	Inc. Y848Rr	526	5.5	25.3	26.2

TEST 480. YIELD AND BOLTING EVALUATION, SALINAS, CALIFORNIA, 1979-80

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: November 21, 1979
Harvested: September 15-17, 1980

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	Bolting 8/13	Bolting 9/11
		Pounds	Tons	Percent	Number	Percent	Percent	Percent
Y931H17	5551H5 x Y831E (C31E2)	10,999	31.95	17.24	149	0.4	6.9	7.6
Y931H8	546H3 x Y831E (C31E2)	10,152	29.88	17.01	141	0.7	4.6	5.8
Y947H8	546H3 x Y847	10,144	30.77	16.50	139	0.3	8.4	10.8
Y942H8	546H3 x Y842	10,110	30.03	16.82	138	0.6	10.2	11.9
Y946H8	546H3 x Y846	10,008	30.32	16.56	140	0.6	6.2	7.7
917H8	546H3 x 417 (C17)	9,920	29.65	16.74	137	3.6	3.6	3.8
Y941H8	546H3 x Y841	9,879	30.00	16.47	140	0.5	19.1	20.7
E936H8	546H3 x E736 (C36)	9,860	29.45	16.73	140	0.2	6.8	7.6
US H11	546H3 x F78-36 (979039)	9,815	29.55	16.61	138	0.0	4.5	5.9
Y940H8	546H3 x Y840	9,814	29.59	16.59	131	0.3	13.3	14.7
964H8	546H3 x 364 (C64)	9,795	30.04	16.29	142	1.3	5.5	6.0
Y939H8	546H3 x Y839	9,765	28.91	16.89	138	0.7	20.5	23.5
US H11	546H3 x F77-36 (78016)	9,761	29.55	16.52	139	0.0	3.8	5.1
Y948H8	546H3 x Y848	9,671	29.93	16.18	143	0.9	11.5	13.8
E937H8	546H3 x E837	9,581	29.05	16.48	141	0.3	7.1	8.0
E937H17	5551H5 x E837	9,460	30.17	15.69	150	1.3	8.2	9.9
Mean		9,921	29.93	16.58	140	0.7	8.8	10.2
LSD (.05)		678	NS	0.56	NS	1.1	3.1	3.4
Coefficient of Variation (%)		6.9	6.0	3.4	7.1	157.4	36.0	33.7
F value		2.0*	1.3 NS	3.1**	1.7 NS	4.4**	20.8**	21.4**

1/ 917H8, E936H8, and 964H8 = Salinas productions of US H10B, US H11, and US H7A. 546H3 = C562H0 x C546.
5551H5 = C564H0 x C551.
E837 = C17E2.

TEST 680. 546H3 X POLLINATOR HYBRID TEST, SALINAS, CALIFORNIA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 25, 1980
Harvested: September 22-23, 1980

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot[1/]	Bolting
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent
Y946H8	546H3 x Y846	10,565	30.61	17.28	135	1.2	0.0
Y741H8	546H3 x Y641	10,450	31.59	16.57	128	1.2	0.9
Y931H8	546H3 x Y831E (C31E2)	10,410	30.84	16.93	135	0.3	0.3
Y948H8	546H3 x Y848	10,372	31.23	16.66	137	0.7	0.1
Y731H8	546H3 x Y631E (C31E1)	10,349	30.02	17.27	130	0.3	0.0
964H8	546H3 x 364 (C64)	10,262	29.60	17.30	137	0.6	0.0
Y939H8	546H3 x Y839	10,181	29.63	17.12	133	0.4	0.5
Y941H8	546H3 x Y841	10,043	29.59	17.04	132	0.4	0.5
Y942H8	546H3 x Y842	10,003	29.37	17.06	135	0.8	0.1
E936H8	546H3 x E736 (C36)	9,773	30.34	16.13	141	0.1	0.0
US H10B	546H3 x C17 (86169)	9,745	29.91	16.37	137	2.8	0.4
Y940H8	546H3 x Y840	9,575	28.29	16.89	128	0.0	0.4
8719H8	546H3 x 6719	9,552	27.78	17.26	141	0.2	0.5
E937H8	546H3 x E837	9,506	29.25	16.28	136	1.5	0.0
Y947H8	546H3 x Y847	9,458	28.28	16.74	133	0.6	0.7
US H11	546H3 x F77-36 (78016)	9,034	26.86	16.82	132	0.7	0.0
Mean		9,955	29.57	16.86	134	0.7	0.3
LSD (.05)		616	1.86	0.73	NS	1.4	0.6
Coefficient of Variation (%)		6.2	6.35	4.4	10.0	194.0	199.6
F value		4.1**	3.7**	2.0*	0.7 NS	1.8*	2.1*

1/ Roots with erwinia soft rot at harvest.

TEST 780. HYBRID TEST, SALINAS, CALIFORNIA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 25, 1980
Harvested: September 23-25, 1980

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot Percent	Bolting Percent
E937HL11	8755H0 x E837	12,542	37.13	16.94	135	0.9	0.2
Y931H17	5551H5 x Y831E (C31E2)	12,380	36.18	17.15	141	1.2	0.7
Y941H8	546H3 x Y841	12,062	35.28	17.18	132	0.3	2.5
Y941H17	5551H5 x Y841	12,058	36.21	16.71	137	1.4	3.1
Y931H24	7522H21 x Y831E (C31E2)	12,053	35.61	16.99	130	1.5	0.3
Y946H8	546H3 x Y846	12,011	34.46	17.48	137	1.1	0.3
Y931H8	546H3 x Y831E (C31E2)	11,934	34.34	17.36	129	0.8	0.3
Y941H24	7522H21 x Y841	11,879	34.82	17.15	136	0.8	0.9
US H11	546H3 x F77-36 (78016)	11,842	34.38	17.22	133	0.3	0.3
Y942H24	7522H21 x Y842	11,743	34.17	17.23	124	2.5	1.4
E937H8	546H3 x E837	11,549	34.45	16.84	140	1.8	0.1
E937H24	7522H21 x E837	11,533	33.92	17.01	137	2.9	0.0
E937H23	7551H21 x E837	11,375	34.15	16.67	133	2.6	0.5
E937H17	5551H5 x E837	11,167	35.61	15.68	136	2.9	0.3
E937H25	7522H4 x E837	11,016	33.22	16.58	135	1.4	0.2
US H10B	546H3 x C17 (86169)	10,891	32.66	16.64	138	3.0	0.0
Mean		11,752	34.79	16.93	135	1.6	0.7
LSD (.05)		685	1.90	0.52	NS	1.3	1.1
Coefficient of Variation (%)		5.9	5.5	3.1	7.7	82.0	159.6
F value		3.7**	2.9**	5.3**	1.3 NS	4.0**	5.1**

1/ 546H3 = C562H0 x C546, 5551H5 = C564H0 x C551, 7522H21 = C536H0 x C522, 7551H21 = C536H0 x C551, 7522H4 = C563H0 x C522.
E837 = C17E2.

TEST 1080. F74-718H0 X POLLINATORS HYBRID TEST, SALINAS, CALIFORNIA, 1980

8 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 26, 1980
Harvested: October 2, 1980

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent
Y946H72	F74-718H0 x Y846	12,564	35.06	17.89	140	1.8	0.2
Y931H72	F74-718H0 x Y831E	12,466	34.39	18.16	130	2.7	0.0
Y941H72	F74-718H0 x Y841	11,905	33.32	17.86	135	1.3	2.4
8719H72	F74-718H0 x 6719	11,698	32.28	18.12	124	0.7	0.2
E937H72	F74-718H0 x E837	11,516	33.36	17.25	127	2.9	0.0
Y940H72	F74-718H0 x Y840	11,475	33.36	17.23	137	2.3	0.5
E936H72	F74-718H0 x E736	11,408	33.19	17.19	133	0.8	0.0
US H11	546H3 x F77-36 (78016)	10,918	31.39	17.39	130	0.3	0.0
Mean		11,744	33.29	17.64	132	1.6	0.4
LSD (.05)		794	2.23	0.51	NS	1.7	0.6
Coefficient of Variation (%)		6.7	6.7	2.90	9.0	108.2	161.0
F value		3.9**	2.1*	5.3**	1.6 NS	2.5*	13.1**

TEST 1180. EVALUATION OF ADVANCED MONOGERM INBREDS, SALINAS, CALIFORNIA, 1980

8 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 26, 1980
Harvested: October 6, 1980

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent
Y931H72	F74-718H0 x Y831E	13,588	40.30	16.86	128	4.1	0.0
Y931HL24	8755aa x Y831E	13,029	39.88	16.32	135	2.5	0.0
Y931HL2	7758-3H2 x Y831E	12,964	40.09	16.17	134	3.9	0.0
Y931H8	F70-546H3 x Y831E	12,818	38.57	16.64	130	2.0	0.3
Y931H3	F66-562H0 x Y831E	12,802	38.02	16.86	124	2.6	0.0
Y931HL1	7758-1H2 x Y831E	12,666	38.81	16.33	130	3.7	0.2
Y931H26	C779H0 x Y831E	12,398	37.35	16.59	125	6.8	0.0
US H11	546H3 x F77-36 (78016)	11,799	37.31	15.79	127	1.6	0.0
Mean		12,758	38.79	16.44	129	3.4	0.1
LSD (.05)		957	NS	0.60	NS	2.8	NS
Coefficient of Variation (%)		7.5	7.60	3.70	10.0	82.4	7.6
F value		2.4*	1.3 NS	2.9*	0.7 NS	2.8*	1.5 NS

TEST 2080. ADVANCED USDA AND COMPANY HYBRIDS, SALINAS, CALIFORNIA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: April 8, 1980
Harvested: October 15-16, 1980

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[1/] Percent	Sol. Solids Percent	Non Suc. Sol. Solids Percent	Raw J. Appar. Purity
Monoricca	Hilleshog Hybrid	10,236	28.05	18.26	135	0.9	21.66	3.41	84.33
40619L	Betaseed Hybrid	9,967	30.36	16.43	136	4.8	19.33	2.91	85.02
Y931H8	546H3 x Y831E (C31E2)	9,623	29.13	16.53	131	0.6	19.72	3.19	83.82
Y941H8	546H3 x Y841	9,597	29.04	16.53	126	1.0	19.49	2.96	84.81
8719H8	546H3 x 6719	9,508	28.81	16.52	130	0.8	19.59	3.07	84.38
E937H8	546H3 x E837	9,437	29.57	15.98	137	1.1	19.06	3.08	83.87
Y946H8	546H3 x Y846	9,405	28.82	16.31	133	0.8	19.30	2.99	84.50
Y940H8	546H3 x Y840	9,316	28.61	16.27	129	0.5	19.24	2.97	84.58
HH 28	Holly Hybrid	9,141	28.28	16.18	134	1.9	19.27	3.09	84.01
9451-07	Holly Hybrid	9,115	26.64	17.11	132	0.2	20.49	3.39	83.47
SS-X111Z	Spreckels Hybrid	9,102	26.80	16.99	130	1.0	19.93	2.94	85.26
Mono 309	Hilleshog Hybrid	9,039	27.75	16.31	124	0.2	19.53	3.23	83.49
US H11	546H3 x F77-36 (78016)	8,917	28.20	15.86	136	0.1	18.88	3.01	84.09
GWD2	GW MonoHy D2	8,851	27.18	16.28	137	2.8	19.40	3.13	83.92
US H10B	546H3 x C17 (86169)	8,846	28.25	15.66	135	2.3	18.62	2.96	84.14
SS E1	Spreckels Hybrid	8,817	27.90	15.81	135	0.3	18.94	3.14	83.48
Mean		9,307	28.34	16.44	132	1.2	19.53	3.09	84.20
LSD (.05)		472	1.29	0.39	NS	1.5	0.51	NS	NS
Coefficient of Variation (%)		5.1	4.6	2.4	10.8	126.4	2.6	12.0	2.0
F value		5.8**	4.6**	20.0**	0.6 NS	5.2**	15.6**	1.3 NS	0.9 NS

1/ Roots with erwinia soft rot at harvest.

TEST 880. COMBINING ABILITY EVALUATION OF MONOGERM, RANDOM-MATING POPULATIONS, SALINAS, CA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 25, 1980
Harvested: September 29-30, 1980

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent
Y931H8	546H3 x Y831E	13,072	38.41	17.01	135	0.8	0.2
Y931HL19	8742aa x Y831E	13,399	39.49	16.96	130	1.2	0.6
Y931HL18	8741aa x Y831E	13,387	38.75	17.28	140	2.1	0.0
Y931HL23	8745aa x Y831E	13,275	38.71	17.13	135	1.7	0.2
Y931HL24	8755aa x Y831E	13,214	39.26	16.77	136	2.0	0.2
Y931HL17	8740aa x Y831E	13,062	37.87	17.24	140	2.0	0.3
Y931HL26	8790aa x Y831E	12,845	36.74	17.44	137	0.8	0.5
Y931HL28	8796-2aa x Y831E	12,807	36.90	17.32	130	1.1	0.0
Y931HL27	8796-1aa x Y831E	12,740	37.09	17.11	136	1.6	0.2
Y931HL21	8744aa x Y831E	12,639	36.33	17.38	136	2.3	0.3
Y931HL29	8746aa x Y831E	12,571	35.45	17.73	133	0.8	0.9
E937H8	546H3 x E837	11,633	35.62	16.34	130	2.0	0.2
E937HL24	8755aa x E837	13,028	39.38	16.54	139	1.1	0.0
E937HL21	8744aa x E837	12,445	36.66	16.96	141	1.8	0.0
E937HL23	8745aa x E837	12,024	36.84	16.34	135	2.1	0.4
US H11	546H3 x F77-36 (78016)	11,493	35.47	16.20	125	0.7	0.0
Mean		12,727	37.44	16.98	135	1.5	0.2
LSD (.05)		667	1.80	0.49	NS	NS	NS
Coefficient of Variation (%)		5.3	4.9	2.9	8.7	95.1	242.7
F value		6.0**	4.8**	6.4**	1.1 NS	1.3 NS	1.7 NS

1/ Y831E = C31E2. E837 = C17E2.

TEST 980. GCA EVALUATION OF SIMILAR CMS (HO) AND GENETIC MS (aa) LINES
SALINAS, CALIFORNIA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 26, 1980
Harvested: Sept. 30-Oct. 1, 1980

Variety	Description[1]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	Bolting
		Pounds	Tons	Percent	Number	Percent	Percent
Y931H8	546H3 x Y831E	13,408	37.70	17.81	136	0.9	0.2
E937H8	546H3 x E837	11,945	34.68	17.21	134	0.5	0.2
Y931HL9	8744HO x Y831E	11,800	33.81	17.46	135	3.9	0.0
Y931HL21	8744aa x Y831E	12,657	34.86	18.14	131	1.4	0.3
Y931HL10	8745HO x Y831E	12,049	35.69	16.89	131	3.9	0.0
Y931HL23	8745aa x Y831E	12,862	37.17	17.32	128	2.0	0.2
Y931HL11	8755HO x Y831E	13,087	37.04	17.74	133	1.8	0.0
Y931HL24	8755aa x Y831E	13,178	37.40	17.64	135	1.7	0.3
E937HL9	8744HO x E837	11,312	32.88	17.18	133	4.0	0.0
E937HL21	8744aa x E837	11,842	34.84	17.05	135	1.5	0.2
E937HL10	8745HO x E837	11,328	33.19	17.03	138	1.8	0.0
E937HL23	8745aa x E837	11,708	35.23	16.63	133	3.6	0.2
E937HL11	8755HO x E837	12,980	38.77	16.76	137	2.3	0.8
E937HL24	8755aa x E837	12,476	36.63	17.06	137	1.9	0.5
Y931HL15	7796-2HO x Y831E	12,393	34.76	17.78	133	0.9	0.3
Y931HL14	7796-1HO x Y831E	12,153	34.94	17.45	135	1.7	0.6
Grand Mean		12,324	35.60	17.32	134	2.1	0.2
LSD (.05)		820	2.54	0.51	NS	1.9	0.5
C. V. (%)		6.7	7.2	3.3	7.7	92.2	214.1
F value		5.0**	3.5**	4.5**	0.5 NS	2.7**	1.9*
CMS (HO) hybrid means		12,093A[2]	35.23A	17.18A	--	3.0A	0.1A
aa hybrid means		12,454B	36.02A	17.31A	--	2.0B	0.3B
Y831 hybrid means		12,720A	36.24A	17.57A	--	2.2A	0.1A
E837 hybrid means		11,942B	35.17B	16.99B	--	2.2A	0.2A

1/ Y831E = C31E2. E837 = C17E2. aa = genetic male sterility. HO = cytoplasmic male sterility. 8744, 8745, 8755, 7796-1, and 7796-2 = monogerm, self-fertile, random-mating populations.

2/ Means with the same letter are not significantly different.

TEST 1280. GENETIC IMPROVEMENT IN SUGAR YIELD, SALINAS, CALIFORNIA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 28, 1980
Harvested: October 8-9, 1980

Variety[1]	Description[2]	Acre Yield		Sucrose	Beets/ 100'	Root Rot[3]	Bolting 8/13	Bolting 10/6
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent	Percent
Y931H72	F74-718H0 x Y831E	14,361	42.83	16.77	142	2.7	0.2	0.2
Y941H72	F74-718H0 x Y841	13,606	41.48	16.43	133	2.4	0.4	2.0
Y931H8	546H3 x Y831E	13,522	39.75	17.01	133	1.9	0.0	0.2
915H8	546H3 x 915	13,389	40.76	16.47	133	2.2	0.2	0.2
917H8	546H3 x 417	13,118	40.85	16.11	130	5.9	0.0	0.2
964H8	546H3 x 364	12,889	40.58	15.89	128	1.2	0.0	0.1
959H8	546H3 x 959	12,724	39.57	16.08	122	2.3	0.4	0.7
Y905H8	546H3 x 68-9163	12,610	37.85	16.71	121	3.5	0.7	1.9
968H8	546H3 x 468	12,445	38.28	16.29	125	1.8	0.2	0.3
Y906	Inc. R&G OT-42	12,164	36.58	16.64	121	1.9	1.9	3.2
964H2	4547H1 x 364	12,091	36.47	16.63	125	1.5	0.2	0.3
915	Inc. 915	11,870	35.95	16.54	123	1.8	0.3	0.5
959	Inc. 959	11,745	36.30	16.18	127	2.6	0.2	0.8
968	Inc. 468	11,221	36.03	15.59	118	3.9	0.0	0.0
Y905	Inc. 68-9163	10,667	31.46	16.95	118	3.8	4.2	7.5
US 22/3	Logan	8,397	26.63	15.78	126	1.5	42.4	52.1
Mean		12,301	37.58	16.38	126	2.6	3.2	4.4
LSD (.05)		685	1.82	0.53	NS	2.2	2.2	2.3
Coefficient of Variation (%)		5.6	4.9	3.3	11.8	87.0	69.1	52.8
F value		32.9**	39.03**	4.82**	1.5 NS	2.4**	181.7**	246.8**

1/ 917H8, 964H8, 964H2 = 1979 USDA productions of US H10B, US H7A, and US H6, respectively.
2/ 417 = Inc. C17; 915 = Inc. US 15; 364 = Inc. C64; 468 = Inc. US 75; 959 = Inc. US 56/2; 68-9163 = Inc. R&G Pioneer; Y831E = C31E2; and 4547H1 = MS of NB1 x NB5.
3/ Roots with Erwinia soft rot at harvest.

TEST 1980. GENETIC IMPROVEMENT IN SUGAR YIELD, SALINAS, CALIFORNIA, 1980

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: April 8, 1980
Harvested: October 14-15, 1980

Variety[1]	Description[2]	Acre Yield		Sucrose	Beets/ 100'	Root Rot[3]	Bolting
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent
Y931H72	F74-718H0 x Y831E	10,818	34.47	15.69	136	1.5	0.0
915H8	546H3 x 915	10,503	33.12	15.86	136	1.9	0.0
Y931H8	546H3 x Y831E	10,046	31.91	15.75	129	1.8	0.0
Y941H72	F74-718H0 x Y841	9,900	32.42	15.29	134	1.2	0.0
917H8	546H3 x 417	9,717	31.67	15.35	138	3.5	0.0
964H8	546H3 x 364	9,524	30.89	15.41	134	0.8	0.0
964H2	4547H1 x 364	9,345	29.81	15.67	129	1.2	0.0
E936H8	546H3 x E736	9,287	30.37	15.28	138	0.3	0.0
959H8	546H3 x 959	9,173	29.49	15.56	130	1.7	0.0
Y905H8	546H3 x 68-9163	9,059	28.07	16.13	131	1.4	0.0
Y906	Inc. R&G OT-42	8,854	27.85	15.91	120	3.2	0.0
968H8	546H3 x 468	8,795	29.05	15.14	138	1.1	0.0
915	Inc. 915	8,371	27.24	15.36	116	1.5	0.2
959	Inc. 959	8,236	26.57	15.51	122	1.4	0.0
Y905	Inc. 68-9163	7,985	24.46	16.32	124	2.9	0.0
968	Inc. 468	7,706	26.38	14.63	115	2.0	0.0
Mean		9,207	29.61	15.55	130	1.7	0.01
LSD (.05)		414	1.26	0.33	13.1	0.99	
Coefficient of Variation (%)		4.6	4.3	2.1	10.2	83.6	
F value		35.1**	37.4**	12.1**	2.7**	2.9**	

1/ E936H8, 917H8, 964H8, 964H2 = 1979 USDA productions of US H11, US H10B, US H7A, and US H6, respectively.
2/ 417 = Inc. C17; 915 = Inc. US 15; 364 = Inc. C64; 468 = Inc. US 75; 959 = Inc. US 56/2; 68-9163 = Inc. R&G Pioneer; Y831E = C31E2; and 4547H1 = MS of NB1 x NB5.
3/ Roots with erwinia soft rot at harvest.

TEST 1480-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF ADVANCED YELLOWS RESISTANT HYBRIDS, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries and 2 virus treatments
2-row plots, 30 ft. long

Planted: April 2, 1980
Noninoculated[1/]
Harvested: October 27-28, 1980

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
Y939H8	546H3 x Y839	11,012	31.29	17.62	143	0.6
Y931H8	546H3 x Y831E (C31E2)	10,996	31.22	17.62	143	0.4
Y940H8	546H3 x Y840	10,845	31.54	17.22	141	0.5
Y946H8	546H3 x Y846	10,665	30.90	17.26	136	0.3
Y941H8	546H3 x Y841	10,640	30.85	17.27	138	0.2
Y942H8	546H3 x Y842	10,562	30.80	17.14	138	0.1
964H8 (US H7)	546H3 x 364 (C64)	10,435	30.19	17.28	139	0.1
US H11	546H3 x F77-36 (78016)	9,977	29.53	16.89	140	0.0
Mean		10,642	30.79	17.29	140	0.3
LSD (.05)		571	1.21	NS	NS	NS
Coefficient of Variation (%)		5.3	3.90	3.20	4.8	247.6
F value		2.8*	2.4*	1.5NS	1.1NS	0.7NS

1/ The BWYV inoculated performance and % loss data are summarized on the following page.

TEST 1480-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF ADVANCED YELLOWS RESISTANT HYBRIDS, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries and 2 virus treatments
2-row plots, 30 ft. long

Planted: April 2, 1980
Inoculated: June 5, 1980
Harvested: October 27-28, 1980

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellow Score[2/]	
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/12	8/26
		Lbs/A	%	T/A	%	%	%	Number	%		
Y941H8	546H3 x Y841	9,525	10.4	27.94	9.3	17.02	1.3	136	0.6	3.6	4.1
Y931H8	546H3 x Y831E	9,452	14.0	28.22	9.6	16.74	4.9	138	0.0	2.6	3.5
Y939H8	546H3 x Y839	9,381	14.7	27.82	10.9	16.85	4.3	136	1.3	4.0	4.5
Y942H8	546H3 x Y842	9,086	14.0	27.66	10.1	16.43	4.2	135	0.3	3.4	4.4
Y946H8	546H3 x Y846	9,018	15.0	27.38	11.1	16.45	4.6	137	0.6	4.0	4.3
Y940H8	546H3 x Y840	8,678	19.5	27.00	14.2	16.03	6.7	139	0.3	4.0	4.9
964H8	546H3 x 364	8,526	18.3	26.45	12.4	16.11	6.7	134	0.5	5.1	5.9
US H11	546H3 x F77-36	8,488	14.7	26.75	9.2	15.82	6.4	137	0.3	2.9	3.8
Mean		9,019	15.1	27.40	10.9	16.43	4.9	136	0.5	3.7	4.4
LSD (.05)		740	NS	NS	NS	0.58	NS	NS	NS	0.69	0.61
Coefficient of Variation (%)		8.1	56.6	6.1	62.0	3.5	95.2	5.3	181.3	18.6	13.6
F value for variety		2.6*	0.9NS	1.1NS	0.5NS	4.4**	1.2NS	0.4NS	1.4NS	10.2**	11.9**
F value for virus		76.9**		71.9**		40.3**		0.3NS	3.0NS		
F value for variety x virus		0.9NS		0.6NS		1.0NS		0.6NS	0.7NS		

2/ Severity of yellows symptoms rated from 0 (no symptoms) to 9.

TEST 1580-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION
OF ADVANCED USDA AND COMPANY HYBRIDS, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 2, 1980
Noninoculated[1/]
Harvested: October 20, 1980

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot[2/]	Sol. Solids	Non Suc. Sol. Solids	Raw J. Appar. Purity
		Pounds	Tons	Percent	Number	Percent	Percent	Percent	
7335-012	Holly Hybrid	10,940	31.75	17.23	141	0.0	20.6	3.4	83.7
Y931HL11	8755HO x Y831E(C31E2)	10,714	32.21	16.68	144	1.0	20.0	3.3	83.5
40619L	Betaseed Hybrid	10,581	32.14	16.43	139	3.9	19.9	3.5	82.6
E937H8	F70-546H3 x E837	10,378	32.07	16.18	138	0.3	19.2	3.0	84.4
GWD2	Monohy D2	9,977	30.28	16.49	145	0.8	20.0	3.5	82.7
SS-X811E	Spreckels Hybrid	9,729	29.79	16.35	140	1.4	19.8	3.4	82.7
US H11	546H3 x F77-36 (78016)	9,637	30.40	15.86	135	0.0	19.4	3.5	81.9
Mono 309	Hilleshög Hybrid	9,227	28.64	16.13	134	0.2	19.6	3.5	82.1
Mean		10,148	30.91	16.42	140	1.0	19.8	3.4	82.9
LSD (.05)		719	2.11	0.36	NS	2.0	0.51	NS	1.5
Coefficient of Variation(%)		7.0	6.8	2.2	7.4	208.7	2.6	10.1	1.8
F value		5.6**	3.2**	10.8**	1.2NS	3.4**	5.6**	1.9NS	2.6*

1/ The BWYV inoculated performance and % loss data are summarized on the following page.
2/ Frequency of roots with soft rot (Erwinia root rot) at harvest.

TEST 1580-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION
OF ADVANCED USDA AND COMPANY HYBRIDS, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 2, 1980
Inoculated: June 5, 1980
Harvested: October 20, 1980

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Yellow Score[4]		Sol.	Non Suc. Sol.	Raw J. Appar.
		Inoc.	Loss[3]	Inoc.	Loss	Inoc.	Loss	8/12	8/26	Solids	Solids	Purity
		Lbs/A	%	T/A	%	%	%			%	%	
Y931HL11	8755HO x Y831E	9,931	7.2	30.59	4.7	16.24	2.5	2.4	2.5	19.6	3.4	82.8
E937H8	546H3 x E837	9,020	12.3	29.29	8.3	15.42	4.6	2.3	2.6	18.8	3.4	82.2
7335-012	Holly Hybrid	8,827	18.9	27.31	13.5	16.15	6.2	4.3	4.1	19.5	3.3	83.0
US H11	546H3 x F77-36	8,620	10.3	28.06	7.5	15.34	3.2	2.4	3.3	18.6	3.3	82.5
40619L	Betaseed Hybrid	8,559	18.5	27.63	13.8	15.48	5.6	4.3	5.5	18.9	3.4	82.1
SS-X811E	Spreckels Hybrid	8,390	13.7	26.60	10.4	15.76	3.5	4.1	4.3	19.0	3.2	83.1
GWD2	Monohy D2	7,695	22.8	24.86	17.8	15.48	6.1	5.8	6.9	18.7	3.2	82.7
Mono 309	Hilleshög Hybrid	6,678	27.4	22.64	20.5	14.75	8.5	6.8	7.4	18.8	4.0	78.6
Mean		8,465	16.4	27.12	12.1	15.58	5.0	4.0	4.6	19.0	3.4	82.1
LSD (.05)		678	7.8	1.91	7.4	0.38	3.0	0.79	0.68	0.6	0.4	1.9
Coefficient of Variation(%)		7.9	47.4	7.0	60.6	2.4	58.2	19.5	14.7	3.1	12.8	2.3
F value for variety		16.3**	6.0**	13.8**	4.3**	12.7**	3.6**	35.8**	61.0**	3.1**	2.9*	4.8**
F value for virus		220.9**		407.6**		39.3**				19.8**	0.1NS	12.6**
F value for variety x virus		4.4**		3.0**		3.0**				1.5NS	1.9NS	2.3*

3/ LSD (.05) for differences within varieties for different virus treatments for sugar yield, beet yield, and % sucrose are 616 lbs/A, 1.8 T/A, and 0.38%, respectively. These values approximately represent losses of 6.1%, 5.8%, and 2.3%, respectively.

4/ Severity of yellows symptoms rated from 0 (no symptoms) to 9.

TEST 1680-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF HYBRIDS WITH MONOGERM, SELF-FERTILE, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 2, 1980
Noninoculated[1/]
Harvested: October 21, 1980

Variety	Description[2/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
Y931H8	F70-546H3 x Y831E	9,955	30.75	16.16	135	0.0
Y931HL23	8745aa x Y831E	9,572	29.78	16.05	130	0.3
Y931HL24	8755aa x Y831E	9,469	29.72	15.88	127	0.4
Y931HL21	8744aa x Y831E	9,333	28.51	16.31	125	0.7
E937HL24	8755aa x E837	9,139	29.53	15.36	132	0.4
E937HL23	8745aa x E837	8,910	29.08	15.32	123	0.3
E937HL21	8744aa x E837	8,894	28.59	15.49	132	0.7
E937H8	F70-546H3 x E837	8,840	28.57	15.48	134	0.0
Mean		9,264	29.32	15.75	130	0.3
LSD (.05)		NS	NS	0.57	NS	NS
Coefficient of Variation (%)		8.9	6.9	3.6	8.6	285.0
F value		1.8 NS	1.2 NS	3.8**	1.2 NS	0.6 NS

1/ The BWYV inoculated performance and % loss data are summarized on the following page.

2/ Y831E = C31E2. E837 = C17E2 (C37 = C17E3). 8744, 8745, 8755 are S^f-RM populations that have been improved by mass selection for yellows and Erwinia root rot resistance and gross sugar yield.

TEST 1680-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF HYBRIDS WITH MONOGERM, SELF-FERTILE, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 2, 1980
Harvested: October 21, 1980
Inoculated: June 5, 1980

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows Scores 3/	
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/12	8/26
		Lbs/A	%	Tons/A	%	%	%	Number	%		
E937HL24	8755aa x E837	8,711	3.7	29.43	0.1	14.76	3.6	149	0.3	2.0	2.6
Y931H8	F70-546H3 x Y831E	8,659	12.0	28.23	7.5	15.29	5.3	141	0.0	2.3	2.9
Y931HL23	8745aa x Y831E	8,595	9.4	27.87	6.3	15.42	3.5	134	0.0	2.0	2.4
Y931HL24	8755aa x Y831E	8,546	8.3	28.80	2.2	14.82	6.5	140	0.0	2.4	3.1
E937HL21	8744aa x E837	8,312	5.5	28.20	0.8	14.71	4.9	142	0.4	2.1	2.5
Y931HL21	8744aa x Y831E	8,076	13.3	26.30	7.5	15.31	6.2	144	0.3	2.0	2.5
E937HL23	8745aa x E837	8,069	9.7	27.10	6.7	14.82	3.3	145	0.0	2.0	2.3
E937H8	F70-546H3 x E837	8,036	8.8	27.31	4.2	14.71	4.8	149	0.0	2.1	2.6
Mean		8,376	8.8	27.91	4.4	14.98	4.8	143	0.1	2.1	2.6
LSD (.05)		NS	NS	1.83	NS	0.45	NS	9.4	NS	NS	0.45
C. V. (%)		7.5	107.0	6.5	182.6	3.0	93.1	6.5	494.0	21.8	17.1
F value for varieties		1.7 NS	0.9 NS	2.4*	1.1 NS	3.7**	0.6 NS	2.5*	0.7 NS	0.8 NS	3.1**
F value for virus		17.3**		7.3*		24.1**		3.6 NS	2.4 NS		
F value for variety x virus		1.0 NS		1.3 NS		0.7 NS		1.9 NS	0.2 NS		

3/ Severity of yellows symptoms rated from 0 (no symptoms) to 9.

TEST 1780-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF O. P. BREEDING LINES, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications
20 entries and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 3, 1980
Noninoculated[1/]
Harvested: October 22-23, 1980

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
Y731	Inc. Y631E(C31E1)	9,343	28.36	16.49	123	0.0
F79-31	Inc. C31E2	9,328	28.59	16.31	115	0.4
Y931E	YR-ER Y631E	9,162	28.37	16.18	113	0.0
Y946	Inc. Y846	9,070	28.23	16.07	119	0.0
Y741	Inc. Y641	8,993	28.92	15.56	115	0.3
Y939	Inc. Y839	8,862	26.67	16.57	117	0.7
Y941	Inc. Y841	8,747	27.35	15.99	117	1.9
Y947	Inc. Y847	8,594	26.86	15.99	122	0.0
Y948	Inc. Y848	8,495	27.02	15.73	123	0.3
Y940	Inc. Y840	8,493	27.32	15.55	124	0.7
Y942	Inc. Y842	8,425	26.27	15.99	112	0.3
Y923	YR-ER Y723	8,014	24.99	16.06	99	0.6
964	Inc. 364(C64)	7,977	26.15	15.26	114	0.0
Y926	YR-ER Y726	7,929	23.64	16.76	129	0.0
968	Inc. 468(US 75)	7,914	26.26	15.06	117	0.0
Y930	YR-ER Y730	7,776	24.53	15.82	97	0.0
SP6822-0	Lot 6519	7,704	24.47	15.70	123	1.4
F78-36	Inc. F77-36	7,688	25.44	15.09	129	0.0
917	Inc. 417(C17)	7,353	24.60	14.93	124	4.3
E937(C37)	YR-ER E737	6,900	22.28	15.48	122	0.0
Mean[2/]		8,338	26.32	15.83	118	0.5
LSD (.05)		811	2.42	0.59	11	1.1
Coefficient of Variation (%)		9.8	9.30	3.80	9.4	209.7
F value		5.6**	4.4**	5.9**	4.6**	6.5**

1/The BWYV inoculated performance and % loss data are summarized on the following page.

2/Means between noninoculated and inoculated treatments were significantly different for sugar and beet yield and % sucrose. Significant interactions occurred for sugar and beet yield and % sucrose.

TEST 1780-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF O. P. BREEDING LINES, SALINAS, CALIFORNIA, 1980

Split-block with 8 replications
20 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 3, 1980
Inoculated: June 5, 1980
Harvested: October 22-23, 1980

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows Scores 4/	
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/12	8/26
		Lbs/A	%	T/A	%	%	%	Number	%		
F79-31	Inc. C31E2	8,711	6.6	27.26	4.8	15.96	2.1	121	0.0	1.9	2.5
Y731	Inc. Y631E (C31E1)	8,522	8.6	26.44	6.6	16.09	2.4	121	0.8	3.0	3.5
Y939	Inc. Y839	8,310	5.4	25.24	5.1	16.36	1.1	120	1.0	2.9	3.5
Y741	Inc. Y641	8,077	9.8	26.51	7.9	15.22	2.2	129	0.7	3.1	4.0
Y941	Inc. Y841	7,959	8.3	25.66	5.5	15.40	3.7	123	0.6	2.5	2.5
Y931E	YR-ER Y631E	7,938	12.9	24.91	11.6	15.87	2.0	112	0.4	2.9	3.5
Y946	Inc. Y846	7,886	13.1	25.26	10.5	15.56	3.2	127	0.0	2.6	3.3
Y942	Inc. Y842	7,884	6.6	25.74	1.9	15.26	4.5	119	0.0	2.5	2.5
Y947	Inc. Y847	7,650	10.4	24.99	6.6	15.32	4.2	131	0.7	2.9	2.6
Y948	Inc. Y848	7,519	11.6	24.98	7.8	15.06	4.2	125	0.0	3.0	3.9
Y940	Inc. Y840	7,316	13.6	24.57	9.7	14.85	4.5	128	0.3	2.9	3.5
Y926	YR-ER Y726	7,218	9.2	21.68	8.5	16.63	0.8	136	0.0	3.1	3.1
F78-36	Inc. F77-36	6,865	10.7	23.68	7.1	14.48	4.0	132	0.0	2.1	2.9
Y923	YR-ER Y723	6,840	14.4	22.46	9.6	15.21	5.3	102	0.5	4.0	4.9
917	Inc. 417 (C17)	6,788	6.4	23.32	4.1	14.49	3.0	119	3.5	1.5	1.4
964	Inc. 364 (C64)	6,668	16.5	22.84	12.6	14.55	4.7	119	0.8	4.9	5.1
Y930	YR-ER Y730	6,354	16.9	21.50	11.3	14.78	6.5	95	0.0	3.0	4.0
968	Inc. 468 (US 75)	6,201	21.7	22.12	15.8	14.01	7.0	112	0.0	5.6	6.1
E937 (C37)	YR-ER E737	6,142	11.3	20.61	7.6	14.83	4.2	131	0.0	1.8	1.6
SP6822-0	Lot 6519	5,188	32.0	18.16	25.3	14.28	9.0	127	0.3	7.1	6.6
Mean 2/		7,302	12.3	23.90	9.0	15.21	3.9	121	0.5	3.2	3.6
LSD (.05)		778	9.4	2.39	8.3	0.69	4.0	11.9	1.3	0.7	0.6
Coefficient of Variation (%)		10.8	77.5	10.10	93.6	4.60	103.8	9.9	278.3	23.5	17.2
F value		10.7**	3.3**	7.2**	2.9*	8.4**	2.0**	5.6**	2.8**	26.4**	38.5**

3/ LSD (.05) for differences within varieties for different virus treatments for sugar yield is 518 lbs/A which approximately represents a 6.2% loss.

4/ Severity of yellows symptoms rated from 0 (no symptoms) to 9.

TEST 1880-NONINOCULATED. GENETIC ADVANCE FOR YELLOWS RESISTANCE,
SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 3, 1980
Noninoculated[1/]
Harvested: October 9-10, 1980

Variety[2/]	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
917H8	546H3 x 417	8,900	27.88	15.94	135	1.3
964H8	546H3 x 364	8,765	27.36	16.02	139	0.0
964H2	4547H1 x 364	8,385	25.90	16.18	133	1.3
Y906	Inc. R&G OT-42	7,850	24.53	16.01	123	0.8
Y905	Inc. 68-9163	7,687	22.74	16.88	125	1.1
915	Inc. 915	7,593	23.86	15.92	109	0.0
959	Inc. 959	7,583	23.58	16.06	129	0.7
968	Inc. 468	7,560	24.12	15.63	120	1.1
Mean		8,040	24.99	16.08	127	0.8
LSD (.05)		459	1.38	0.39	13.5	0.0
Coefficient of Variation (%)		5.7	5.5	2.4	10.6	177.8
F value		12.1**	14.6**	6.9**	4.0**	1.2 NS

1/ The BWYV inoculated performance data are summarized on the following page.

2/ 917H8, 964H8, 964H2, Y906, Y905, 915, 959, and 968 correspond to 1979 increases of US H10B, US H7A, US H6, R&G Old Type, R&G Pioneer, US 15, US 56/2, and US 75, respectively.

TEST 1880-BWYV INOCULATED. GENETIC ADVANCE FOR YELLOWS RESISTANCE,
SALINAS, CALIFORNIA, 1980

Split-block with 8 replications (varieties in LS)
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 3, 1980
Harvested: October 9-10, 1980
Inoculated: June 5, 1980

Variety[2]	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows Scores[3]	
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/12	8/26
		Lbs/A	%	Tons/A	%	%	%	Number	%		
917H8	546H3 x 417	7,459	15.7	24.95	10.3	14.93	6.3	134	0.9	1.5	1.8
964H8	546H3 x 364	7,208	16.1	23.84	11.6	15.13	5.5	127	0.0	3.6	4.3
964H2	4547H1 x 364	6,996	16.0	22.86	11.2	15.30	5.4	134	0.7	3.0	3.6
959	Inc. 959	6,102	18.6	20.35	12.9	14.99	6.6	133	0.0	4.1	5.4
Y906	Inc. R&G OT-42	5,870	25.0	20.08	18.0	14.58	8.8	119	0.4	6.0	6.6
968	Inc. 468	5,741	23.7	20.14	16.5	14.23	8.8	112	0.8	4.5	5.0
915	Inc. 915	5,612	25.5	19.68	16.7	14.23	10.6	102	0.9	5.8	6.5
Y905	Inc. 68-9163	5,441	28.5	17.79	21.2	15.28	9.4	122	0.3	5.6	6.5
Mean		6,303	21.1	21.21	14.8	14.83	7.7	123	0.5	4.3	5.0
LSD (.05)		560	8.6	1.64	NS	0.49	3.8	9.8	NS	0.72	0.61
C. V. (%)		8.8	40.4	7.7	53.9	3.3	48.9	7.9	232.5	16.6	12.2
F value for variety		16.4**	2.9*	17.7**	1.9 NS	6.5**	2.2*	11.1**	0.8 NS	38.1**	63.2**
F value for virus		48.6**		31.7**		89.7**		0.3 NS	1.1 NS		
F value for variety x virus		1.1 NS		0.8 NS		2.1 NS		0.9 NS	0.7 NS		

2/ See footnote on previous page.

3/ Severity of yellows symptoms rated from 0 (no symptoms) to 9.

TEST 1380. POWDERY MILDEW EVALUATION OF ADVANCED HYBRIDS, SALINAS, CALIFORNIA, 1980

Split-block with 4 replications
2 sulfur treatments
4-row plots, 60 ft. long

Planted: February 1, 1980
Harvested: September 25-26, 1980

Variety[1]	Sugar Yield/A			Beet Yield/A			Sucrose			Powd. M. 7/22	
	Sulfur[2]	No Sulfur	Loss[3]	Sulfur	No Sulfur	Loss	Sulfur	No Sulfur	Loss	Sulfur	No Sulfur
	Pounds	Pounds	%	Tons	Tons	%	%	%	%	Score	Score
Y931H8	10,683	9,751	8.8	30.65	27.98	8.8	17.43	17.41	0.1	1.8	4.8
Y941H8	10,374	9,161	11.7	30.18	27.31	9.5	17.19	16.80	2.3	1.0	3.8
Y946H8	9,896	9,576	3.5	29.02	27.87	4.2	17.07	17.16	-0.6	1.5	5.3
US H11	9,694	8,925	7.8	28.88	26.90	6.8	16.81	16.59	1.2	3.8	7.0
Mean[4]	10,162A	9,353A	8.0	29.68A	27.51A	7.3	17.13A	16.99A	0.8	2.0A	5.2B
LSD (.05)	504	589	4.8	1.55	NS	NS	NS	0.43	NS	0.5	1.3
C. V. (%)	2.9	3.6	35.1	3.0	4.6	49.5	2.2	1.5	411.8	14.4	14.5
F value	9.5**	4.9*	6.0*	3.8 NS	0.6 NS	1.7 NS	2.0 NS	8.6*	0.6 NS	70.0**	13.1**
F value for V x S	4.4*	4.4*	--	1.6 NS	1.6 NS	--	0.7 NS	0.7 NS	--	1.6 NS	1.6 NS

1/ Y931H8, Y941H8, Y946H8, US H11 (979038) = 546H3 x C31E2, Y841, Y846, or C36, respectively.

2/ Powdery mildew first observed about June 20, 1980. Sulfur applications were made on 6/24, 7/7, 8/11, and 9/8/80 using about 10 lbs/A of wettable sulfur.

3/ Test Reliability = Reliability should be fair for variety performance but very poor for the differential effects of PM. By chance, in two of the four replications, the sulfur treated blocks were on poorer sites than their nontreated pairs, and the potential damage due to PM was grossly under estimated. Also, due to frequent wheel traffic and very slow water infiltration rates, the plants were frequently stressed for water. The development of severe PM was retarded by the nonthrifty plants and the continued replacement of water stressed, older leaves.

4/ Treatment means with a letter in common are not significantly different.

TEST 2580-1. REACTION TO ERWINIA AND POWDERY MILDEW, SALINAS, CALIFORNIA, 1980

20 entries x 4 replications, RCB
1-row plots, 24 ft. long

Planted: April 30, 1980
Inoculated: July 16, 1980
Harvested: October 31, 1980

Variety	Description	No. Roots	ERR Reaction DI[1]	ERR Reaction % Healthy[2]	P. M. Scores[3] 8/7	8/10	8/16
Y905	Inc. 68-9163(R&G Pioneer)	141	7.01	85.1	4.25	4.25	5.50
Y906	Inc. R&G OT-42	151	11.83	82.8	4.50	5.25	5.75
Y424	Inc. Y124(US 22/3)	135	6.64	88.1	4.50	5.00	5.50
915	Inc. 915(US 15)	133	5.75	85.7	2.00	1.75	3.00
959	Inc. 959(US 56/2)	144	2.76	92.4	4.75	3.75	5.75
968	Inc. 468(US 75)	123	14.22	77.2	5.00	5.00	6.00
917	Inc. 417(C17)	144	36.94	41.7	4.50	4.25	5.50
E936	Inc. E736(C36)	140	0.29	97.9	5.50	5.00	6.50
964	Inc. 364(C64)	130	0.11	98.5	1.50	2.25	4.00
964H2	4547H1 x 364(US H6)	152	2.38	91.4	3.75	3.75	4.25
964H8	546H3 x 364(US H7A)	166	2.03	91.6	3.50	3.75	5.25
917H8	546H3 x 417(US H10B)	166	11.36	75.9	6.75	6.75	7.00
E936H8	546H3 x E736(US H11)	144	0.75	93.8	6.50	5.75	7.00
Y931H8	546H3 x Y831E(C31E2)	146	2.72	91.1	3.50	3.75	4.75
F78-546H3	562HO x 546(78155)	160	3.58	87.5	5.25	5.00	6.25
4547H1	1502HO x 2547(ms of NB1xNB5)	142	0.59	93.7	7.50	7.50	7.75
E840	Inc. E640(Erwinia susc. ck.)	116	76.20	8.6	4.50	4.00	5.75
Y941	Inc. Y841	147	3.55	94.6	1.75	1.50	3.25
Y931E	YR-ER Y631E	134	4.93	91.8	2.75	2.25	3.75
E937HL11	8755HO x E837	149	6.36	87.9	4.50	4.75	5.75

1/DI=Disease Index=Σ percent rot/no. of roots. Plants scored on a scale of 0, 1, 7, 25, 50, 75, 93, and 100% rot per root. ERR=Erwinia root rot.
2/Roots with scores of 0 and 1% rot were considered healthy.
3/PM=powdery mildew. Ratings made on a scale of 0 to 9.

NOTE: Although problems were experienced with the inoculum in 1980 and the level of disease incidence is lower than expected, DI ratings appear to picture correctly the relative reaction for these varieties. The DI values are probably more useful in this test than the % healthy data because of the large number of escapes.

TEST 2580-2: EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, SALINAS, CA, 1980

Planted: April 30, 1980
Inoculated: July 16, 1980
171 entries x 2 replications — 2nd Rep Reinoc.: August 27, 1980
1-row plots, 24 ft. long — Harvested: October 28-31, 1980

Variety	Description	No. Roots	ERR Reaction DI[1]	ERR Reaction % Healthy[2]	P. M. Scores[3] 8/10	P. M. Scores[3] 8/16
HYBRIDS						
HH27	Holly Hybrid (rec. 1979)	81	2.28	91.4	1.5	3.5
GWD2	Monohy D2 77-115	82	17.09	68.3	5.0	6.5
1443	Betaseed	77	16.27	63.6	3.0	4.5
Hh 545	Hilleshog (rec. 1978)	73	26.41	61.6	2.5	4.0
Monotunno	" "	74	20.72	59.5	2.5	4.5
US H11	U836H8 (78016)	74	2.00	89.2	5.5	7.0
US H10B	546H3 x C17 (86169)	76	17.03	59.2	6.5	8.0
SSX111Z	Spreckels (rec. 3/7/80)	83	13.69	73.5	4.0	6.0
SSX811E	"	78	3.62	88.5	5.5	6.0
SSE1	"	65	1.69	92.3	6.5	6.5
7335-012	Holly (rec. 2/27/80)	65	8.62	83.1	3.0	3.5
GWD2	MonoHy D2 (rec. 2/11/80)	78	14.54	64.1	5.5	5.0
40619L	Betaseed (rec. 3/5/80)	80	22.84	61.3	4.0	4.5
Monoricca	Hilleshog (rec. 2/21/80)	81	5.19	90.1	3.5	3.5
Mono 309	" "	65	16.23	75.4	3.5	4.5
Mono 1491	" "	81	15.96	61.7	4.5	5.0
US H8	546H3 x NB7 (Holly)	80	6.24	83.8	6.5	7.5
US H9B	546H3 x C13 (1050)	83	16.37	69.9	6.0	7.5
US H10B	546H3 x C17 (8616)	89	14.02	70.8	6.0	7.5
US H11	546H3 x F77-36 (78016)	88	1.67	94.3	6.5	7.5
US H11	546H3 x C36 (979038)	87	3.30	88.5	7.0	7.5
E840H8	546H3 x E640	89	20.56	60.7	5.5	6.5
8717H8	" x 7717	89	1.98	88.8	6.0	7.0
8719H8	" x 6719	86	4.09	83.7	6.0	6.5

1/DI=Disease index= Σpercent rot/no. of roots. Plants scored on a scale of 0, 1, 7, 25, 50, 75, 93, and 100% rot per root. EER=Erwinia root rot.
2/Roots with scores of 0 and 1% rot were considered healthy.
3/PM=powdery mildew. Ratings made on a scale of 0 to 9.

NOTE: Because of problems encountered with the Erwinia inoculum, comparisons should primarily be made within sets of entries (denoted by dotted lines). Because the infection rate tended to become less severe as the Erwinia inoculum aged, the 2nd replication was reinoculated on August 27. More healthy plants (in many cases escapes) and lower DI's were measured in this test than expected, but the DI's do appear to accurately picture relative variety reactions.

TEST 2580-2: EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, SALINAS, CA, 1980

Variety	Description	No. Roots	ERR Reaction DI[1]	ERR Reaction % Healthy[2]	P. M. Scores[3] 8/10	P. M. Scores[3] 8/16
917H8	546H3 x 417 (C17E0)	90	11.93	76.7	5.5	7.0
E837H8	" x E737 (C17E1)	88	6.32	84.1	5.5	7.0
E937H8	" x E837 (C17E2)	89	8.03	79.8	5.0	6.0
E937H17	5551H5 x E837	88	6.35	81.8	5.5	7.0
E937H23	7551H21 x E837	85	10.29	80.0	6.5	7.5
E937H24	7522H21 x E837	89	12.78	69.7	7.0	7.5
E937H25	7522H4 x E837	83	6.60	84.3	6.5	6.0
E937H72	F74-718HO x E837	80	10.09	77.5	5.0	5.5
E937HL21	8744aa x E837	64	14.67	75.0	5.5	7.0
E937HL23	8745aa x E837	62	12.58	69.4	5.5	7.0
E937HL24	8755aa x E837	64	20.19	65.6	4.5	6.0
Y631H8	546H3 x Y331 (C31E0)	67	8.75	67.2	4.5	5.0
Y731H8	" x Y631E (C31E1)	65	8.49	80.0	5.0	5.5
Y931H8	" x Y831E (C31E2)	67	6.22	85.1	4.5	5.0
Y931H17	5551H5 x Y831E	69	9.70	79.7	4.0	5.0
Y931H24	7522H21 x Y831E	63	17.21	66.7	6.0	6.5
Y931H26	8779HO x Y831E	61	20.41	70.5	3.0	4.5
Y931H72	F74-718HO x Y831E	64	25.73	57.8	4.5	5.0
Y931HL21	8744aa x Y831E	62	11.39	80.6	6.5	7.0
Y931HL23	8745aa x Y831E	63	19.35	74.6	5.5	6.5
Y931HL24	8755aa x Y831E	66	19.61	63.6	4.0	5.5
US H10B	546H3 x C17 (86169)	63	15.13	74.6	6.0	6.5
US H11	U836H8 (78016)	65	0.72	93.8	6.0	7.0
E840H8	546H3 x E640	59	29.93	42.4	5.5	6.5
Y939H8	546H3 x Y839	78	1.91	91.0	6.0	7.0
Y940H8	" x Y840	74	8.77	81.1	5.0	7.5
Y941H8	" x Y841	73	2.12	91.8	4.5	6.0
Y942H8	" x Y842	80	4.18	85.0	5.0	6.5
Y946H8	" x Y846	79	3.05	88.6	5.5	6.5
E936H8	" x E736	80	1.38	91.3	6.5	7.5
Y947H8	" x Y847Rr	81	4.90	88.9	6.0	6.5
Y948H8	" x Y848Rr	77	4.45	89.6	6.5	7.5

TEST 2580-2: EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, SALINAS, CA, 1980

Variety	Description	No. Roots	ERR Reaction DI[1/]	ERR Reaction % Healthy[2/]	P. M. Scores[3/] 8/10	P. M. Scores[3/] 8/16
OPEN-POLLINATED LINES						
Y923	YR-ER Y723	73	4.29	94.5	2.5	4.0
Y926	YR-ER Y726	68	2.46	92.6	3.0	4.0
Y930	YR-ER Y730	71	10.73	80.3	7.5	7.5
Y631	Inc. Y331 (C31)	73	10.86	80.8	4.0	5.5
Y731	Inc. Y631 (C31E1)	76	7.22	89.5	4.0	6.0
Y931(Sp.)	Inc. Y831E (C31E2)	73	5.04	90.4	4.5	6.0
F79-31	Inc. Y831E (C31E2)	63	7.48	88.9	4.0	5.0
Y931E(Iso.)	YR-ER Y631E	73	3.05	95.9	3.5	5.5
813	Inc. 413C (C13)	70	45.14	31.4	5.0	6.0
F77-36	Inc. C36 (7322)	63	2.06	90.5	5.5	7.0
F78-36	Inc. F77-36 (78087)	69	1.29	95.7	5.0	7.0
F79-36	Inc. C36	67	2.09	92.5	6.0	7.0
E936	Inc. E736 (Iso.)	66	0.15	98.5	5.5	7.0
E840	Inc. E640	67	62.09	16.4	5.0	6.0
Y939	Inc. Y839	66	6.36	90.9	3.0	4.5
E637	Inc. E537 (C17E1)	70	16.39	71.4	4.5	6.5
E937(Sp.)	Inc. E837 (C17E2)	74	4.97	89.2	5.5	6.0
E937(Iso.)	YR-ER E737 (C17E3=C37)	65	1.20	98.5	5.0	6.0
917	Inc. 417 (C17E0)	69	37.25	42.0	4.5	6.0
964	Inc. 364 (C64)	56	3.14	92.9	2.5	5.0
Y440	Inc. 3254	54	11.65	81.5	3.5	5.5
Y740	Inc. Y640	61	3.98	88.5	3.0	5.5
Y940	Inc. Y840	65	7.37	86.2	3.5	5.5
Y441	Inc. 3255	60	6.42	86.7	3.0	5.0
Y741	Inc. Y641	57	1.00	96.5	3.5	5.0
Y941	Inc. Y841	57	1.61	94.7	3.0	4.5
Y746	Inc. Y646	63	2.68	96.8	3.5	6.0
Y946	Inc. Y846	55	3.93	89.1	3.5	5.5
Y942	Inc. Y842	67	1.48	92.5	6.0	7.0
F78-36	Inc. F77-36	62	1.77	96.8	4.5	6.5
E840	Inc. E640	46	72.61	2.2	4.5	6.0
Y947	Inc. Y847Rr	57	6.65	87.7	4.0	5.0
Y948	Inc. Y848Rr	50	7.18	84.0	4.5	5.0

TEST 2580-2: EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, SALINAS, CA, 1980

Variety	Description	No. Roots	ERR Reaction DI[1]	ERR Reaction % Healthy[2]	P. M. Scores[3] 8/10	P. M. Scores[3] 8/16
PM-1	634-46-4-2F	125	0.47	96.0	2.0	3.5
PM-2	435-8-1A-2A	111	0.17	98.2	2.0	3.5
PM-3	435-8-1A-2B	62	0.02	100.0	2.5	4.0
PM-4	435-8-2A-1F	133	0.14	98.5	2.5	4.0
PM-5	435-8-1A-2B	32	0.0	100.0	2.0	5.0
PM-6	634-46-4-2	66	0.0	100.0	2.0	3.0
PM-7	435-11-4-1	27	3.04	92.6	5.0	5.0
PM-8	435-8A-1-2	30	0.50	93.3	2.0	5.0
PM-9	634-46-4-2-2	34	2.32	97.1	2.0	6.0
SELF-FERTILE, RANDOM-MATING LINES						
9740	YR-ER 7740B (A,aa)	82	2.95	90.2	4.0	5.5
9741	YR-ER 7741B (A,aa)	83	3.61	88.0	5.5	6.5
9742	YR-ER 7742 (A,aa)	88	3.36	90.9	4.5	6.5
9744	YR-ER 7744 (A,aa)	77	8.53	76.6	4.5	6.0
9745	YR-ER 7745 (A,aa)	82	8.18	76.8	6.5	7.0
9746	8746aa x A	90	3.03	91.1	5.5	7.0
7755	6755aa x A	86	9.77	76.7	5.0	6.5
8755	7755Baa x A	88	6.98	84.1	4.5	5.5
9755	YR-ER 7755B (A,aa)	80	2.81	95.0	3.5	5.0
E840	Inc. E640	59	46.71	30.5	5.5	6.0
9790	8790aa x A	84	1.80	96.4	6.5	7.5
9790D	T-O-Sel. 8790Daa x A	84	2.35	90.5	6.0	7.5
9790DC1	7790D⊗	86	7.07	89.5	5.5	6.0
9796-1	8796-1aa x A	75	11.95	70.7	7.0	8.0
9796-2	8796-2aa x A	84	2.36	95.2	7.5	8.0
9789	8789aa x A	81	1.14	96.3	4.0	5.0
SELF-FERTILE LINES						
8717	Inc. 7717	59	9.14	83.1	3.5	6.0
8719	Inc. 6719	62	0.04	100.0	3.0	4.5
9717C1	YR-ER 7717⊗	32	2.34	93.8	4.0	7.0
9719C1	YR-ER 7719C1⊗	38	1.34	97.4	4.0	7.0
9720C1	ER-YR 7207⊗	37	0.70	97.3	7.0	7.0
9723C1	ER-YR 7203⊗	29	4.83	86.2	5.0	7.0
8722C1	YR-ER 6209⊗	38	2.05	94.7	4.0	6.0
8719BC1	6719⊗	36	2.08	97.2	3.0	5.0
E840	Inc. E640	68	61.12	19.1	5.0	6.0
F78-36	Inc. F77-36 (78087)	69	3.62	91.3	5.0	6.5

TEST 2580-2: EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, SALINAS, CA, 1980

Variety	Description	No. Roots	ERR Reaction DI[1]	ERR Reaction % Healthy[2]	P. M. Scores[3] 8/10	P. M. Scores[3] 8/16
7758-3	Inc. 6758-3	68	23.09	58.8	5.0	6.0
7758-1	Inc. 6758-1	73	7.55	84.9	7.0	7.5
9758-1	ER-YR 6758-1 (C758)	33	2.06	87.9	5.0	7.0
9767E-1	ER-YR 7563E	57	6.35	71.9	4.0	5.5
9767E-2	ER-YR 7562E	37	0.86	89.2	6.0	6.0
8562	Inc. F66-562	68	14.25	58.8	5.5	6.5
8562HO	F66-562HO x F66-562	58	15.03	58.6	6.5	7.0
F67-563	Lot 7433	67	7.75	67.2	6.0	6.5
F67-563HO	Lot 7432	79	6.05	68.4	6.5	7.0
9566	Inc. 7563-30C1	79	1.20	91.1	6.5	7.5
F78-546	Inc. F70-546 (78156)	57	0.25	96.5	4.0	6.0
9546E	ER-YR 7546E	81	1.26	98.8	3.5	5.5
9718	Inc. 3718 (Iso.)	80	7.84	75.0	6.0	6.5
9718HO	3718HO x 3718	75	7.01	81.3	6.5	8.0
F79-779	Inc. C779 (79435)	75	17.99	68.0	1.0	2.0
F79-779HO	C779CMS x C779 (79434)	68	29.21	51.5	1.0	2.0
F78-546H3	562HO x 546 (78155)	85	1.65	94.1	6.5	8.0
9718H3	F66-562HO x 3718 (Iso.)	85	7.54	78.8	7.0	8.0
9718H26	8779HO x 3718 (Iso.)	78	14.35	61.5	6.0	7.0
9718HL9	8744HO x 3718 (Iso.)	73	12.92	57.5	6.5	7.5
9718HL11	8755HO x 3718 (Iso.)	78	8.23	74.4	7.0	7.5
9718H22	7522HO x 3718 (Iso.)	80	9.61	71.3	7.5	9.0
8536H22	6522-29HO x F75-536	77	7.84	66.2	8.0	9.0
9563-30H72	3718HO x 7563-30	85	1.32	88.2	7.0	8.0
MISCELLANEOUS LINES						
9211	Inc. 7235 Cb-	39	14.26	59.0	3.0	5.0
9212	Inc. 7235 cbcb	38	4.55	78.9	5.0	6.0
9217	Inc. 7238 Cb-	35	45.14	20.0	5.0	6.0
9218	Inc. 7238 cbcb	39	21.08	59.0	6.0	7.0
9219	Inc. 7231 Cb-	36	3.67	83.3	7.0	7.0
9220	Inc. 7231 cbcb	39	10.97	79.5	6.0	7.0
9223	Inc. 7232 Cb-	39	0.46	94.9	5.0	6.0
9224	Inc. 7232 cbcb	44	24.73	63.6	4.0	6.0

TEST 2580-2: EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, SALINAS, CA, 1980

Variety	Description	No. Roots	ERR Reaction DI[1/]	ERR Reaction % Healthy	P. M. Scores[3/] 8/10	P. M. Scores[3/] 8/16
5323-05		31	22.68	67.7	4.0	4.0
7323-012		27	3.04	92.6	4.0	6.0
7334-011		30	22.80	56.7	5.0	5.0
7335-02		27	23.15	63.0	4.0	5.0
7335-010		29	32.34	51.7	4.0	4.0
7335-011		27	26.74	55.6	5.0	4.0
E840	Inc. E640	12	76.00	8.3	5.0	6.0
8478-08		28	28.36	57.1	4.0	5.0
9337-02		28	8.86	71.4	7.0	8.0
9437-03		30	10.30	83.3	1.0	2.0
9450-06		29	18.66	58.6	4.0	6.0
9452-05		31	9.71	74.2	5.0	6.0
US H10B	546H3 x C17 (86169)	26	40.54	34.6	6.0	7.0
US H11	U836H8 (78016)	29	5.86	89.7	4.0	7.0
US H11	AC836H8 (78050)	28	2.29	89.3	5.0	7.0
SS E1	Sprex (1978 lot)	29	4.62	89.7	5.0	7.0
FODDER BEET						
M.L.R.	Mammoth Long Red	72	8.72	80.6	2.0	2.0
G.Y.I.	Giant Yellow Intern.	61	5.21	82.0	4.0	5.5
H.S.R.	Half-Sugar Rose	72	2.11	90.3	3.0	4.5

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1979-80

Location: USDA-SEA, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam

Previous crops: 1979 and 1977, cereal nurseries; 1978, sugarbeet tests.

Fertilization: Preplant: 560 lbs of 46:0:0 and 720 lbs of 11:48:0 on 3 acres.
Sidedress: 100 lbs/A 46:0:0.

Summary: 1979-80 Tests, Brawley, California

Test No.	Sowing Date 1978[1]	Entries per Test	No. Reps.	Rows per Plot[2]	Plot Length Ft.	1980 Harvest Date	Test Design
B180	9/5	10	4	1	24	7/22-24	3
B280	9/6	16	8	2	24	5/15-16	RCB
B380	9/6	16	8	2	24	5/14-15	RCB
B480	9/6	16	8	2	24	5/13-14	RCB
Obs-1	9/5	16	2	1	24	Observation	test
Obs-2	9/5	16	2	1	24	"	"

1/ Watered 9/5-7/1979.
2/ Rows 32" wide.
3/ Split-split-plot with 2 inoc. dates and 4 disease trtmts.

Irrigations: Sprinkled as needed to establish stands. Then furrow irrigated on 10/23, 11/29, 2/4, 3/17, and 4/14 with about 4" per irrigation.

Thinned: 9/29-30.

Herbicide: 10/24, 1 gal. Eptam 7E through irrigation water.

Diseases and insects: 9/13, 2/3 pt Parathion 6E for flea beetles; 9/24, 12.8 ounces Lannate for army worms; 10/10, 0.7 lb Lannate for army worms and loopers. 1/15/80, 40 lbs/A and 3/15, 40 lbs/A sulfur dust for powdery mildew control.

Harvest and sugar analyses: Plots were dug with Holly's spike wheel lifter and sugar analyses made by Holly's tare lab.

Remarks: Stands were excellent. Test reliability should be good. Effects from diseases and insects appeared to be of little consequence.

We wish to acknowledge J. Robertson and C. Brown, I. V. Cons. Research Center, for plot supervision and P. Thomas, Davis, for data processing.

TEST B280. IMPERIAL VALLEY 546H3 X POLLINATOR HYBRID TEST, 1979-80

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 5-6, 1979
Harvested: May 15-16, 1980

Variety	Description[3]	Acre Yield[1] Sugar Pounds	Acre Yield[1] Beets Tons	Sucrose Percent	Bolting Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[2]
Y931HL11	8755HO x Y831E	11,550	34.66	16.67	0.0	178	96.9	1.2
E937HL11	8755HO x E837	11,191	35.01	16.01	0.8	168	95.6	1.7
Y731H8	546H3 x Y631E	11,041	33.25	16.64	0.0	176	96.2	1.4
Y946H8	546H3 x Y846	10,955	32.99	16.68	0.0	177	96.3	1.4
Y931H8	546H3 x Y831E	10,876	32.55	16.77	0.0	180	96.7	1.8
Y941H8	546H3 x Y841	10,584	31.87	16.63	0.0	171	96.1	1.5
Y947H8	546H3 x Y847	10,533	32.06	16.44	0.0	172	95.8	1.4
US H11	546H3 x F77-36 (78016)	10,481	32.28	16.24	0.2	178	94.8	1.4
Y942H8	546H3 x Y842	10,410	31.83	16.42	0.1	156	96.6	1.4
Y940H8	546H3 x Y840	10,246	31.88	16.13	0.0	174	96.0	1.3
E937H8	546H3 x E837	10,134	31.23	16.26	0.0	169	95.1	1.4
964H8	546H3 x 364	10,118	31.61	16.09	0.0	175	96.6	1.4
Y948H8	546H3 x Y848	10,077	31.00	16.28	0.1	175	95.7	1.3
Y939H8	546H3 x Y839	10,068	31.48	16.07	0.9	180	95.9	1.5
US H10B	546H3 x C17 (86169)	10,058	31.26	16.14	0.0	186	94.6	1.6
E936H8	546H3 x E736	9,879	31.07	15.93	0.0	176	94.9	1.3
Mean		10,513	32.25	16.34	0.1	174	95.9	1.4
LSD (.05)		472	1.59	NS	0.4	12.5	1.2	0.0
C. V. (%)		4.5	5.00	4.60	298.1	7.2	1.2	43.5
F value		8.3**	4.47**	1.10 NS	4.1**	2.2*	2.8**	0.5 NS

1/ Yields adjusted to clean weight basis.
2/ Brei NO_3-N by Orion probe. Ratings of 1, 2, ..., 9 correspond to NO_3-N values of 0 to >250 ppm and to diphenylamine spot test ratings of 1 through 5.
3/ Y831E = C31E2; Y631E = C31E1; E837 = 2 cycles of Erwinia resistance sel. from C17, C37 = 3 cycles of ER sel.; C42 = ER sel. from Y842; E936H8 = USDA production of US H11; 364 = Inc. of C64 and 964H8 = USDA production of US H7A.

TEST B380. IMPERIAL VALLEY HYBRID TEST, 1979-80

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 6, 1979
Harvested: May 14-15, 1980

Variety	Description[1/]	Acre Yield		Sucrose	Bolting	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Sugar Pounds	Beets Tons	Percent	Percent	Number	Percent	Rating
Y731H33	3546H72B x Y631E	11,323	34.42	16.50	0.0	161	96.9	1.2
Hybrid-2	7335-02	11,137	33.07	16.86	0.3	174	97.7	1.3
Y931H24	7522H21 x Y831E	11,091	33.10	16.85	0.0	180	96.2	1.2
Y931H17	5551H5 x Y831E	10,980	33.27	16.54	0.0	180	96.8	1.1
Y931H8	546H3 x Y831E	10,891	31.83	17.14	0.0	175	97.4	1.5
Y941H24	7522H21 x Y841	10,872	33.15	16.47	0.0	176	96.9	1.1
Y941H17	5551H5 x Y841	10,717	32.86	16.34	0.0	173	96.8	1.3
Y942H24	7522H21 x Y842	10,712	32.02	16.78	0.3	166	96.8	1.1
E937H17	5551H5 x E837	10,604	32.89	16.18	0.0	171	94.9	1.4
Hybrid-3	7337-02	10,364	30.74	16.94	0.0	167	96.4	1.4
US H11	546H3 x F77-36 (78016)	10,264	32.37	15.92	0.0	176	95.5	1.1
E937H25	7522H4 x E837	10,198	32.47	15.80	0.0	177	94.4	1.1
E937H8	546H3 x E837	10,071	31.49	16.00	0.0	169	96.2	1.2
Hybrid-1	7326-02	9,970	31.16	16.06	0.1	173	95.3	1.1
E937H24	7522H21 x E837	9,921	30.74	16.19	0.0	181	94.6	1.0
E937H23	7551H21 x E837	9,645	30.02	16.08	0.0	171	94.8	1.3
Mean		10,548	32.23	16.42	0.05	173	96.1	1.2
LSD (.05)		528	1.58	0.53	0.2	NS	1.1	NS
C. V. (%)		5.1	5.00	3.30	476.5	7.0	1.2	39.3
F value		7.0**	4.25**	4.64**	1.8*	1.6 NS	6.9**	0.8 NS

1/ Y631E = C31E1; Y831E = C31E2; 3546H72 = 718 CMS x 546; 7522H21 = 536 CMS x 522; 5551H5 = 564 CMS x 551; 546H3 = 562 CMS x 546; 7522H4 = 563 CMS x 522; 7551H21 = 536 CMS x 551.

TEST B480. IMPERIAL VALLEY TEST OF GENETIC IMPROVEMENT IN SUGAR YIELD, 1979-80

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 6, 1979
Harvested: May 13-14, 1980

Variety[1]	Description[2]	Acre Yield		Sucrose	Bolting	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Sugar	Beets					
		Pounds	Tons	Percent	Percent	Number	Percent	Rating
Y931H72	F74-718H0 x Y831E	11,229	32.83	17.18	0.0	166	97.5	1.3
Y941H72	F74-718H0 x Y841	11,171	33.59	16.65	0.3	165	97.7	1.4
917H8	546H3 x 417	10,748	31.11	17.31	0.0	172	95.6	1.7
915H8	546H3 x 915	10,427	31.31	16.68	0.0	167	96.6	1.7
Y931H8	546H3 x Y831E	10,215	29.36	17.48	0.0	170	97.0	1.6
964H8	546H3 x 364	10,197	29.82	17.16	0.0	175	97.1	1.6
E936H8	546H3 x E736	10,083	29.81	16.97	0.0	180	94.9	1.6
968H8	546H3 x 468	9,689	29.10	16.73	0.0	176	96.4	1.6
959H8	546H3 x 959	9,670	28.97	16.78	0.0	163	96.4	1.6
Y905H8	546H3 x 68-9163	9,352	27.01	17.38	0.5	170	95.1	1.6
915	Inc. 915	9,255	28.34	16.35	0.0	169	96.0	1.7
964H2	4547H1 x 364	8,954	26.58	16.98	0.0	169	97.7	1.4
968	Inc. 468	8,759	26.69	16.46	0.3	167	96.7	1.5
959	Inc. 959	8,622	25.72	16.81	0.0	167	96.1	1.5
US 22/3	From Logan	7,560	23.69	16.08	32.6	162	96.3	1.6
Y905	Inc. 68-9163	7,276	21.59	16.91	5.9	164	93.5	1.8
Mean		9,575	28.47	16.87	2.5	169	96.3	1.6
LSD (.05)		699	2.20	0.63	2.3	NS	1.0	NS
C. V. (%)		7.4	7.80	3.80	95.4	8.7	1.1	37.4
F value		21.4**	16.42**	2.88**	96.0**	1.0 NS	9.3**	0.3 NS

1/ 917H8 = USDA production of US H10B; 964H8 = USDA production of US H7A; E936H8 = US H11; 964H2 = US H6.
2/ 417 = Inc. C17; 915 = Inc. US 15; 364 = Inc. C64; E736 = Inc. C36; 468 = Inc. US 75; 959 = Inc. US 56/2; 68-9163 = Inc. R&G Pioneer.

VARIETY TEST, TRACY, CA, 1979-80
By Holly Sugar Corporation (973B)

18 entries x 5 reps, RCB
2-rows, 19 ft., 30" rows

Planted: March 24, 1979
Harvested: April 21, 1980

Variety	Description	Ext. Sugar/A	Gross Sugar/A	Beets/ A	Sucrose	Beets/ 100'	Bolting	PPM Na	PPM K
		Pounds	Pounds	Tons	Percent	Number	Percent		
8719H8	546H3 x 6719	12,252	13,974	52.2	13.39	152	11.8	171	225
8717H8	546H3 x 7717	12,096	13,871	52.3	13.26	146	6.1	182	249
E506H33	(718 x 546) x E406	11,280	13,109	51.4	12.73	143	10.3	190	257
E506H31	(562 x 718) x E406	10,971	12,646	49.2	12.81	159	11.2	189	238
US H10E		10,646	12,303	46.8	13.13	161	7.8	199	218
Y731H33	(718 x 546) x Y631E	10,489	12,469	49.2	12.67	140	2.6	246	254
Y731H8	546H3 x Y631E	10,430	12,181	47.3	12.89	159	5.0	226	232
E736H31	(562 x 718) x C36	10,239	12,023	48.6	12.35	147	7.9	213	231
Y731H30	(706 x 536) x Y631E	10,221	12,063	47.9	12.59	147	4.6	241	239
Y731HL11	(718 x 758-3) x Y631E	10,178	12,131	50.7	11.92	148	4.3	251	255
E506H8	546H3 x E406	10,159	11,932	49.6	12.03	150	10.2	217	235
Y741H8	546H3 x Y641	10,019	12,002	49.5	12.15	200	5.8	250	232
Y740H8	546H3 x Y640	9,904	11,619	46.8	12.39	153	5.9	239	211
E536H33	(718 x 546) x C36	9,878	11,841	49.2	12.03	157	7.4	239	243
Y731H31	(562 x 718) x Y631E	9,812	11,721	47.9	12.20	155	2.7	246	225
Y731HL10	(718 x 758-1) x Y631E	9,809	11,588	47.2	12.27	145	2.9	256	240
E702H31	(562 x 718) x E602	9,745	11,669	49.0	11.92	148	9.3	224	245
E702H8	546H3 x E602	9,363	11,363	49.2	11.54	151	7.0	251	240
Grand Mean		10,416	12,250	49.1	12.46	153	6.8	224	237
C.V. (%)		10	9	6.7	4.92			13.24	6.03
LSD (.05)		1,331	1,399	NS	0.77			37.39	18.03
F value		2.77**	2.21*	1.33 NS	3.46**			4.23**	3.85**

Remarks: Good stands. Powdery mildew in Fall. Rusted fairly heavy in Winter.

VARIETY TEST, WOODLAND, CA, 1979-80
By Betaseed, Inc.

25 entries x 6 replications

Planted: June 4, 1979
Harvested: May 7, 1980

Variety[1/]	Acre Yield: Gross Sugar Pounds	Acre Yield: Rec. Sugar Pounds	Beets Tons	Sucrose Percent	Rec. Sucrose Percent	Bolting Percent
US H9	12,868	10,588	43.5	14.78	12.21	42.4
US H10	13,183	10,879	42.9	15.26	12.57	42.6
HH 22	13,186	11,033	42.8	15.52	12.97	36.7
Y731H8	14,678	11,947	45.8	15.95	12.99	44.2
Y731H29	13,037	10,519	42.5	15.32	12.33	49.9
Y741H8	12,729	10,030	43.8	14.46	11.44	58.4
Y741H29	11,611	9,157	39.9	14.70	11.67	86.2
Y740H8	12,724	10,038	43.3	14.65	11.58	40.5
Y740H29	12,769	9,940	44.8	14.17	11.03	52.5
Mean of test	12,363	9,858	42.8	14.47	11.55	69.4
LSD (.05)	1,295	1,172	4.6	0.88	1.10	8.6
C.V. (%)	9.15	10.41	9.2	5.25	8.27	

1/ H8 = C562CMS x C546. H29 = C718CMS x C536. Y731 = C31E1.

Variety	Qual. Index	Relative Quality Data[2/]: K	Na	NH_2-N	K+Na
US H9	82.6	96	110	100	99
US H10	82.3	105	104	98	105
HH 22	83.6	100	86	101	97
Y731H8	81.5	110	138	101	117
Y731H29	80.4	105	158	98	119
Y741H8	78.9	106	161	106	119
Y741H29	79.3	98	188	102	120
Y740H8	78.9	109	162	105	123
Y740H29	77.8	109	178	101	126
Mean of test	79.6	99	164	100	116
LSD (.05)	3.2	7	42	3	12

2/ Relative to mean US H9, US H10, and HH 22.

TEST 2480. FODDER BEET TEST, SALINAS, CALIFORNIA, 1980

12 entries x 4 replications, RCB
2-row plots, 20 ft. long

Planted: April 9, 1980
Harvested: October 2, 1980

Variety	Acre Yield		Sucrose	Beets/ 100'	Harvested Root
	Sugar	Beets			
	Pounds	Tons	Percent	Number	Number
US H11 (78016)	7,236	23.40	15.49	149	60
Famille O	5,586	38.77	7.40	89	32
Half-Sugar Rose	5,063	36.94	6.84	134	55
Famille P	4,878	40.78	5.98	124	47
Famille Q	4,739	35.65	6.69	118	47
Mammoth Long Red	4,309	39.56	5.46	134	53
Jaune De Vauriac	4,262	36.00	5.95	125	48
Geante Blanche	4,065	48.38	4.16	135	53
White Garden Beet	3,669	28.94	6.38	135	55
Geante Rouge	3,554	37.38	4.77	122	48
Giant Yellow Intermediate	3,356	43.97	3.91	94	37
Jaune De Saint Theogonnec	3,119	47.17	3.29	136	55
Mean	4,486	38.08	6.36	124	49
LSD (.05)	972	7.79	0.99	24	9.1
Coefficient of Variation (%)	15.1	14.2	10.8	13.4	12.9
F value	11.4**	6.8**	84.0**	4.4**	6.4**

Field Evaluation of Root Toughness in Sugarbeet Lines Selected for Low and High Fiber Content

I. O. Skoyen and R. T. Lewellen

Studies were continued in 1980 on root toughness (fiber content of roots) of sugarbeets. Earlier field studies have been reported in Sugarbeet Research--1977 Report, pages A77-A80, -1978 Report, pages A77-A81 and -1979 Report, pages A61-A64. In 1980, the progeny of divergent selections for low and high fiber in three lines and their top-cross hybrids were compared for root toughness in two field tests.

Materials and Methods--Two tests, each with 20 entries, were seeded November 21, 1979 and April 4, 1980. The tests included three parental lines, their low and high root fiber selections and top-cross hybrids with F_1-546H3 and C718HO (Table 1). Root toughness was measured on a single plant basis as ft. lbs. pressure required for a blade to penetrate a root 2.54 cm deep. Measurements were made in half pound increments. Transverse probes were made 1 to 2 inches below the crown.

As in earlier tests, an Effegi penetrometer (used to test fruit firmness at maturity) was used to make root toughness measurements. The blade measured 1 mm x 10 mm (10 sq mm cross section) x 2.54 cm long. The dial of the Effegi penetrometer has a graduated dial capacity of 27 ft. lbs. pressure but pressures to 28 ft. lbs. can be readily interpreted. Root probe measurements were made in the field during the first week of October for Test 2 and during mid-November 1980 for Test 1.

Results and Discussion--Field tests of first cycle selections for low and high fiber showed that root toughness can be significantly changed from that of the parent lines (Table 1). Two out of three low fiber or soft selections (SS designation) had significantly lower mean probe values than the parent lines for both seeding dates. In comparisons of parent lines and high fiber or tough selections (ST designation), the selections were always significantly tougher than their respective parents in both Test 1 and Test 2. Probe values for parent lines although falling about midway between those of the respective soft and tough selections were closer to soft selection values. Root toughness of test hybrids ranged from intermediate to about the same as that of parents and/or selections. Test results demonstrate that variability for root toughness exists and that sugarbeet lines can be selected for less root fiber.

The 1980 data also showed that age of plants was a primary factor in root toughness with the younger roots from Test 2 averaging about two foot pounds less than the older roots of Test 1. A measure of root toughness in older plants (Test 1) is shown in the percentage of plants in a population that had probe values exceeding 28 ft. lbs. Nearly half the roots of high fiber selections 936ST and Y940ST had probe values of 28+ ft. lbs. In Test 2 less than 20% of the roots of these selections exceeded 28 ft. lb. probe values. The Y931ST selection had only 25% 28+ ft. lb. roots in Test 1 but about the same percentage in Test 2 as 936ST and Y940ST.

As observed in earlier tests, bolting has not appeared to be a particular condition to root toughness. However, in 1979-80 (a mild season for induction) significant differences occurred between parent lines and high fiber selections. There were no differences between parent lines and low fiber selections. High fiber content may be somewhat associated with bolting tendency but additional testing is needed to substantiate this.

Arranging toughness measurements into frequency classes showed that the 12- to 20-lb. portion of the distribution accounted for nearly 55% in Test 1 and 72% in Test 2 (Table 1). The differences between low and high fiber selections ranged from 45 to 55% among selections for Test 1 and from 37 to 55% for Test 2. The mean percentage for low and high fiber selections and parent lines of the 12- to 20-lb. portion of the distribution were:

	Test 1 %	Test 2 %
Low fiber (SS)	76	89
High fiber (ST)	27	41
Parent lines	63	77

Yield data were taken for Test 2 in 1981 but there were no differences for yield per acre or percent sucrose between parent lines and their selections.

The value of lower fiber content in sugarbeet has not been established, however, the possibility of easier processing may have a small impact on factory energy consumption and higher quality beet pulp byproduct.

The year to year environmental effect probably has the most important bearing on the fiber content of beet roots. Additional testing of parents, selections and hybrids is needed to assemble information on year vs. fiber content interaction before inferences can be drawn.

Table 1: Sugarbeet root toughness comparisons for high and low fiber root selections and their hybrids, 1980

Line or Hybrid No.	Description	Test 1, Seeded 11/21/79 Roots Probed (Scale of 1 to 28+ Ft. lbs) No. Roots N	Pop. Mean[2] Ft. lbs	Roots 28+ No.	Roots 28+ 28+/N %	Bolt. %	Test 2, Seeded 4/8/80 Roots Probed (Scale of 1 to 28+ Ft. lbs) No. Roots N	Pop. Mean Ft. lbs	Roots 28+ No.	Roots 28+ 28+/N %
936SS	Inc. F78-36SS sel.[1]	129	18.63a[3]	8	6.2	3.1	142	17.91ab	0	0.0
936H72SS	C718HO x F78-36SS sel.	160	19.69b	9	5.6	19.9	164	17.11a	0	0.0
936H8SS	546H3 x F78-36SS sel.	170	19.96b	12	7.0	15.0	166	18.52b	0	0.0
F78-36	Inc. F77-36 (78087)	147	20.30b	20	13.6	4.2	157	18.62b	5	2.5
936H8ST	546H3 x F78-36ST sel.	168	22.55c	43	25.6	10.7	171	20.65c	11	6.4
936ST	Inc. F78-36ST sel.	147	24.01d	67	45.6	15.9	144	21.94d	25	17.4
936H72ST	C718HO x F78-36ST sel.	161	24.39d	75	46.6	26.0	140	19.99c	7	5.0
Group Mean		155	21.36	--	--	13.5	155	19.25	--	--
Group LSD (.05)			0.86					1.19		
Y940SS	Inc. Y740SS sel.	142	17.39a	1	0.7	22.4	152	15.52a	0	0.0
Y940H8SS	546H3 x Y740SS sel.	172	19.32b	13	7.6	16.3	150	16.83b	2	1.3
Y940H72SS	C718HO x Y740SS sel.	157	19.34b	26	16.6	24.3	172	16.64ab	1	0.6
Y740	Inc. YRS 640	164	20.03bc	23	14.0	20.5	161	17.07b	2	1.2
Y940H72ST	C718HO x Y740ST sel.	158	21.07cd	25	15.8	29.8	144	17.96b	3	2.1
Y940H8ST	546H3 x Y740ST sel.	154	21.69d	36	23.4	25.8	128	20.05c	10	7.8
Y940ST	Inc. Y740ST sel.	139	24.33e	66	47.5	33.1	147	22.03d	24	16.3
Group Mean		155	20.45	--	--	24.6	151	18.01	--	--
Group LSD (.05)			1.00					1.27		
Y931H8SS	546H3 x Y731SS sel.	155	17.85a	5	3.2	4.4	150	18.29ab	2	1.3
Y931SS	Inc. Y731SS sel.	153	18.16a	5	3.3	3.1	143	17.36a	1	0.7
Y931H72SS	C718HO x Y731SS sel.	165	18.39a	7	4.2	9.7	135	16.82a	1	0.7
Y731	Inc. Y631E	164	18.94a	10	6.1	4.3	117	19.08bc	4	3.4
Y931H8ST	546H3 x Y731ST sel.	162	21.98b	33	20.4	5.5	163	20.29c	4	2.5
Y931ST	Inc. Y731ST sel.	145	22.70b	37	25.5	16.7	154	22.14d	28	18.2
Group Mean		157	19.66	--	--	7.3	144	18.99	--	--
Group LSD (.05)			1.10					1.48		
Test Means			20.54			15.5		18.74		
LSD (.05)			1.28			10.7		1.29		
C. V. (%)			4.4			48.5		4.9		
F value			23.45**			6.46**		18.55**		

1/ SS = Low fiber (soft) selections. ST = High fiber (tough) selections.
2/ Root probes were made with an Effegi penetrometer equipped with a 1 x 10mm blade (10 sq. mm area) x 2.54cm l.
3/ Test means followed by a common letter are not significantly different at the 5% level - DMR Test.

Table 1: (Continued)

Line or Hybrid No.	Frequency Distribution of Root Toughness (Pounds Pressure)													
	Test 1, Seeded 11/21/79						12-20 Classes Total Probed %	Test 2, Seeded 4/8/80						12-20 Classes Total Probed %
	12-14	15-17	18-20	21-23	24-26	27-28+		12-14	15-17	18-20	21-23	24-26	27-28+	
936SS	23	37	31	19	9	10	70.5	16	53	46	21	5	1	81.0
936H72SS	11	41	47	35	15	11	61.9	34	64	42	21	3	0	85.4
936H8SS	18	37	40	36	25	14	55.9	16	47	61	36	3	3	74.7
F78-36	15	27	44	20	21	20	58.5	18	56	38	26	12	7	71.3
936H8ST	4	22	36	31	27	48	36.9	10	35	46	33	26	21	53.2
936ST	5	12	20	17	24	69	25.1	2	16	46	34	12	34	44.4
936H72ST	2	11	21	27	23	77	21.1	14	38	31	21	22	14	59.3
Group Means							47.1							67.0
Y940SS	39	41	31	20	10	1	78.2	62	57	27	5	1	0	96.0
Y940H8SS	23	36	55	31	13	14	66.3	27	72	37	11	1	2	90.7
Y940H72SS	22	47	40	15	7	26	69.4	44	71	41	10	4	2	90.7
Y740	17	37	45	30	10	25	60.4	34	68	36	16	3	4	85.7
Y940H72ST	9	34	35	30	23	27	49.4	22	50	39	20	8	5	77.1
Y940H8ST	15	22	32	25	19	41	44.8	12	29	31	29	13	14	56.2
Y940ST	5	8	19	16	23	68	23.0	6	23	31	29	21	37	40.8
Group Means							55.9							76.7
Y931H8SS	35	44	42	15	13	6	78.1	12	60	48	22	4	4	80.0
Y931SS	25	41	55	21	5	6	79.1	19	64	47	7	3	3	90.9
Y931H72SS	27	47	51	21	11	8	75.8	29	58	37	8	2	1	91.9
Y731	17	53	46	22	15	11	70.7	8	30	49	17	9	4	74.3
Y931H8ST	8	23	32	36	25	38	38.9	7	31	55	37	23	10	57.0
Y931ST	7	12	29	31	26	40	33.1	2	28	30	38	15	41	39.0
Group Means							62.6							72.2
Test Means							54.8							72.0
Class Means (%)	10.5	20.3	24.1	16.0	11.1	18.0		13.2	31.9	27.4	14.8	6.4	6.9	

Fusarium Stalk Blight Resistance

J. S. McFarlane

Testing was continued at Salem, Oregon, to obtain additional information on the performance of Fusarium resistant selections and on the inheritance of resistance. The test was planted by the West Coast Beet Seed Company on August 17, 1979, in a severely infested field. Heavy infection occurred during the fall months in susceptible breeding lines and many young plants were killed. Stalk blight symptoms developed in July and the plants were classified August 12. Stalk blight grades are given in Tables 1 and 2. Infection among entries range from 0 to 100%. Lines showing high resistance in previous years again received good ratings.

The line 9566 which had been selected from the 563 inbred again performed very well. The stalk blight grade determined from 622 plants was .30 and was similar to grades obtained in 1978 and 1979. This line was increased in 1979-80 and seed has been distributed to breeders under the designation C566. The male sterile 9566HO with the parentage [(502HO x 563) x 564] x 9566 graded 1.63. This CMS was backcrossed to 9566 in 1979-80 and a second backcross is being made in 1980-81. The 80-81 backcross is being made in a Fusarium infested field and another resistant selection is planned. We anticipate the resistance of the resulting C566 CMS will be similar to that of C566.

The line 9536-4 selected from the 4536-97 inbred showed a marked improvement in Fusarium resistance. Likewise a selection from the F_2 population of the cross 563aa x 502 possessed greater resistance than either of the parents.

Uniformity within and among tests. A portion of the entries in the 1980 test was replicated four times and the results were analyzed statistically (Table 3). The grade differences among inbreds were highly significant. Grade differences among replications were substantial for some inbreds (2.60 to 3.94 for 564aa). The coefficient of variation was 8.45%. In a similar replicated test conducted in 1976 the coefficient of variation was 16.43%.

Comparisons were also made with previous tests to determine year-to-year variation (Table 4). Severity of infection varied greatly from year to year but the relative resistance or susceptibility of the various breeding lines remained fairly constant. This was especially true for the highly resistant and the highly susceptible lines. Breeding lines with intermediate resistance tended to vary more widely from year to year. These results show that variation in severity of infection varies from year to year and also from one portion of the field to another. These variations in the infection tended to distort the results and make it difficult to obtain reliable inheritance information.

Table 1. Evaluation of inbred lines to Fusarium stalk blight, Salem, Oregon, 1979-80.

Inbred	Description	No. Plants	Grade[1/]
8554	S_{14} of NB4 inbred	184	.01
9804	Inc. (563aa x S_{14} of NB4)	187	.09
6554	NB4 inbred	125	.17
9803	Inc. (564aa x S_{14} of NB4)	275	.18
9566	Fusarium res. sel. F67-563	622	.30
9802	Inc. (564aa x NB4)	230	.30
8563 (Or[illegible]	S_{14} of 563 inbred	227	.46
F7[illegible]	CMS of 779 inbred	124	.48
9[illegible]	Fusarium res. sel. 536 inbred	68	.76
9505-32	Fusarium res. sel. F_2(563aa x NB1)	37	.76
F79-779	Yellows res. inbred	80	.80
9796-1	[illegible]laa x A-	33	.91
97[illegible]	Yellows res. inbred	82	.93
9790DH0	7790DH0 x T-0 sel. 8790D	58	.98
9745	Yellows-Erwinia res. inbred	42	1.26
9744	Yellows-Erwinia res. inbred	55	1.29
F78-546	CT-bolting res. inbred	77	1.34
8505H0	563H0 x Fusarium res. sels.	257	1.36
8719	Yellows-Erwinia res. inbred	64	1.39
9505-98	Fusarium res. sel. F_2(563aa x NB1)	46	1.48
9566H0	[(502H0 x 563) x 564] x 566	196	1.63
8564aa Iso.	4564aa x 5564Aa	97	1.67
1502H0	CMS of NB1 inbred	26	1.73
8562	Inc. F66-562	212	1.81
7522	CT res. inbred	32	1.81
8562H0	F66-562H0 x F66-562	288	1.99
9522-14	Fusarium res. sel. 522 inbred	40	2.20
F67-563H0	CMS of 563 inbred	226	2.49
9718	Yellows res. inbred	50	2.63
9718H0	CMS of 9718	32	2.72
8563aa	2563aa x 5564Aa	28	3.43
8564aa	[(563aa x 502Aa) x 563Aa] x 564Aa	165	3.47
4536-97	CT res. inbred	34	3.71
8564H0	2nd bc of (502H0 x 562) to 564	80	3.95
8564	CT res. inbred	145	3.97
6564H0	4564H0 x 5564	20	4.00

1/ Stalk blight rated on scale of 0 to 4 with 0 = no disease and 4 = dead plant.

Table 2. Evaluation of open-pollinated lines and hybrids to Fusarium stalk blight, Salem, Oregon, 1979-80.

Entry	Description	No. Plants	Grade[1/]
8102	7564aa x NB4	250	.08
9104	8564aa x NB4	353	.14
9102	(6564H0 x NB4) x NB4	202	.18
F79-31	Inc. C31E2	110	.27
8101	6564H0 x NB4	221	.30
9105	8564aa x (7564aa x NB4)	274	.41
8505H2	502H0 x Fusarium res. sels.	30	.41
F78-36	Erwinia res. sel. C13	80	.63
E937	Erwinia res. sel. C17	74	.64
9103	(6564H0 x NB4) x 8564	267	1.01
F70-17	C17 pollinator	26	1.12
813	C13 pollinator	102	1.35
9566H21	4536-97H0 x 566	36	1.44
9566H26	8779H0 x 566	23	1.52
8505H22	5522-29H0 x Fusarium res. sels.	36	1.97
F78-546H3	562H0 x 546	66	2.06
9566H72	3718H0 x 566	22	2.82
6564H1	(502H0 x 563) x 564	76	3.03
704-15	CT res. sel. Y804	40	3.03
904-15ER	Erwinia res. sel. 504-15	23	3.13
7522H21	536-97H0 x 522	23	3.22

1/ Rated on scale of 0 to 4 with 0 = no disease and 4 = dead plant.

Table 3. Fusarium stalk blight grades of sugarbeet inbreds replicated four times in a test at Salem, Oregon, 1979-80.

Inbred	Description	Grade
6554	Bolting res. inbred	.17
9566 Iso.	Fus. res. sel. F67-563	.27
9566 Sp.	Fus. res. sel. F67-563	.34
9566H0	[(502H0 x 563) x 564] x 566	1.63
F67-563H0	CMS of 563 inbred	2.49
8564aa	[(563aa x 502Aa) x 563Aa] x 564Aa	3.47
8564H0	2nd bc of (502H0 x 562) to 564	3.95
8564	CT res. inbred	3.97
LSD (.05)		.48
C.V. (%)		8.45
F value**		3.36

Table 4. Variation in Fusarium stalk blight grades of sugarbeet breeding lines for the years 1976-80.

Breeding Line	1976	1977	1978	1979	1980
			Grade		
6554	--	.09	.08	.08	.17
8554_{S14}	.04	--	.10	.09	.01
8564	3.86	3.60	3.62	--	3.97
8564H0	--	4.00	3.09	--	3.95
1502H0	.39	.40	.47	--	1.73
F67-563	2.48	2.90	1.35	--	--
F67-563H0	--	2.20	1.00	--	2.49
7522	2.98	1.00	.35	--	1.81
4536-97	3.27	2.90	1.30	--	3.23
9566	--	--	.20	.25	.30
C13	--	.70	.07	.27	1.35
6564H1	1.42	1.20	.09	.67	3.03
7522H21	2.07	1.00	.45	1.73	3.22

Inheritance of resistance. Stalk blight resistance evaluation tests conducted during the past five years have shown a great range in resistance among breeding lines developed at Salinas. The inbred 554, also known as NB4, rarely shows any diseased plants whereas all plants in the 564 inbred are either killed or badly blighted (Table 5). Crosses have been made between the two inbreds and the hybrids then backcrossed to both the resistant and susceptible parents. These hybrids together with F_2 populations were evaluated for resistance in 1980. Data from all populations showed conclusively that resistance is dominant. The mode of inheritance could not be definitely determined because the parents were not completely homozygous and some variation occurred in the test field. The results indicate that resistance is not monogenic and is determined by at least two genes.

A hybrid between the resistant 9566 inbred and the moderately susceptible 6564H1 male sterile parent segregated for resistance and the offspring received a stalk blight resistance rating intermediate between the two parents. The results suggested that more than one gene was involved and that neither of the parents was homozygous.

Linkage studies. Many of the monogerm inbreds developed at Salinas are susceptible to stalk blight whereas most of the multigerm inbreds tend to be resistant or intermediate. We suspected that there might be a linkage between susceptibility and the monogerm character. Hybrids were made between susceptible monogerm parents and resistant multigerm parents. Segregating F_2 and backcross populations from these hybrids were observed for stalk blight susceptibility (Table 6). Each monogerm plant and each multigerm plant was graded. Average grades for the monogerm and multigerm plants in each population were computed. In four of the populations the stalk blight grade level was slightly higher for the monogerm plants and in the fifth population the level was slightly higher for the multigerm plants. If any linkage occurs, it is very loose and would not be a factor in a resistance breeding program.

Table 5. Fusarium stalk blight grades of sugarbeet hybrids and of their inbred parents.

Entry	Description	No. Plants	Grade
8554_{S14}	S_{14} of 554 inbred	184	.01
6554	NB4 inbred	125	.17
8564aa	Mendelian male sterile of 564	165	3.47
8564	Inbred line	145	3.97
8564H0	Cytoplasmic male sterile of 564	80	3.95
8563aa	Mendelian male sterile of 563	28	3.43
9104	564aa x 554	353	.14
9102	(564H0 x 554) x 554	202	.18
9105	564aa x (564aa x 554)	274	.41
9804	F_2(563aa x 554_{S14})	187	.09
9803	F_2(564aa x 554_{S14})	275	.18
9802	F_2(564aa x 554)	230	.30
F67-563	Inbred line	233	2.48
F67-563H0	Cytoplasmic male sterile of 563	226	2.49
1502H0	" " " of 502	26	1.73
6564H1	(502H0 x 563) x 564	76	3.03
9566	Fusarium resistant selection 563	622	.30
9566H0	564H1 x 566	196	1.63
4536-97	Inbred line	34	3.71
9536-4	Fusarium resistant selection 536	68	.76
9505-32	" " " F_2(563aa x 502)	37	.76

Table 6. Comparison of the Fusarium stalk blight susceptibility of multigerm (MM) and monogerm (mm) sugarbeet plants in segregating populations.

Population	Multigerm		Monogerm	
	No. Plants	Ave. Grade 1/	No. Plants	Ave. Grade
(Susceptible mm x Resistant MM) x Susceptible mm	144	.81	123	1.21
Susceptible mm x (Susceptible mm x Resistant MM)	150	.48	124	.31
F_2(Susceptible mm x Resistant MM)	178	.26	52	.42
F_2(Susceptible mm x Resistant MM)	176	.14	99	.26
F_2(Susceptible mm x Resistant MM)	138	.08	49	.12
Ave. all populations	786	.35	447	.54

1/ Rated on scale of 0 to 4 with 0 = no disease and 4 = dead plant. Grade is average for number of plants observed.

INTERSPECIFIC HYBRIDIZATION

Homozygous Nematode-Resistant Sugarbeets and Phenomena of Resistance Transmission

M. H. Yu

Self pollination of self-compatible and interpollination of self-incompatible sugarbeet plants that were heterozygous for nematode resistance gave 674 out of 1,671 (or 40.3%) progeny plants that were resistant. A total of 184 S_2 and F_3 families derived from the resistant S_1 and F_2 parents were screened for nematode resistance transmission. In screening the S_2 and F_3 generations for 100% nematode resistance, a family was discarded if one or more susceptible plants were found. Among the 184 families, five of the S_1 parents gave progeny with 100% nematode resistance. There were no susceptible plants segregating in each of these families based on the examination of the available seedlings. These results indicated that the parents of these five families were homozygous for the resistance factor(s). Excluding the five homozygous resistant families, the average rate of transmission of nematode resistance from the heterozygous S_1 parents was 41.8%, i.e., 442 out of 1,057 plants were resistant. This rate ranged from 28 to 59% within the 25 S_2 families that had been subjected to three screenings. On the other hand, no family was found with 100% transmission of resistance among 34 F_3 families derived from the self-sterile group. These results indicated that about 2.7% (5 out of 184) of the resistant progeny or 1.1% (2.7% of 40.3%) of all progeny, including resistant and susceptible, obtained from self or interpollination of resistant heterozygotes were true-breeding for nematode resistance. Although this recovery frequency is low, the knowledge and plant materials obtained in these tests are important in terms of developing sugarbeet lines with homozygous nematode resistance. The recovery of nematode resistant homozygotes demonstrated that achieving homozygosity of the resistance factor(s) in sugarbeet is feasible and that these plants are viable.

Both S_1 selections 3552 and 3584 were plants true-breeding for nematode resistance and with green hypocotyls. Except for two plants, all S_2 progeny of 3584 showed a comparatively uniform growth profile. Leaves of 3584 progeny plants were slightly smaller and darker green than typical for other sugarbeets, yet the inflorescences of these plants were normal. A small amount of selfed and open-pollinated seeds were harvested from several S_2 plants of 3552 and 3584. Transmission frequencies of nematode resistance from S_2 plants of 3552 and 3584 to their progenies are shown in Table 1. Excluding progenies of the two exceptional S_2 parents (No. 776 and 783), 98.4% of the selfed and open-pollinated progeny of these S_2's were resistant. The remaining 1.6% of progeny (five plants) were susceptible. These five susceptible plants contained 11 to 24 cysts (in one of the three tests) which were beyond the arbitrary criterion of 10 cysts or less per plant for resistance in our screening procedure. In contrast to the abundance of cysts on roots of the susceptible sugarbeets, these four plants could be classified as moderately resistant.

Of the two exceptional 3584 progeny plants, No. 776 had a red hypocotyl and No. 783 had an erect growth profile at early developmental stage. More than 50% of their self-pollinated progenies were susceptible to nematode (Table 1). These two "S_2" parental plants were undoubtedly heterozygous for nematode resistance. The heterozygosity probably resulted from outcrosses to stray pollen grains. Transmission of resistance to 45.9% of their selfed progeny was only slightly higher than that of the resistant heterozygotes at earlier generations, i.e., 40.3% and 41.8%. With normal transmission of a single heterozygous, dominant allele, 75% resistant plants would be expected. This suggested that resistant heterozygous progeny derived from a resistant homozygote acquired little enhancement in rate of transmission of resistance. It provided additional evidence that plant 3552 and others were homozygous in order to produce a transmission rate of 100% for nematode resistance. Thus gametes, at least the megaspores, of resistant homozygotes conferred resistance to progeny regardless of the genetic constitution of gametes with which they united.

Resistant homozygotes were not found in 34 F_3 families of the self-sterile group. Sugarbeets with homozygous nematode resistance should be obtainable from interpollination of F_2 resistant plants. However, all parental plants in the interpollinating group would have to be homozygous for nematode resistance in order to produce F_3 progeny that will breed true for resistance in the following generations. Reciprocal crosses between a resistant homozygous F_2 and a resistant heterozygous F_2 would produce only resistant F_3 progeny if resistance were dominant and contamination with foreign pollen did not occur. In these cases, the proportion of progeny that would be homozygous for resistance will depend upon the rates of transmission of resistance through the eggs and pollen of the heterozygous parent(s). Additional progeny tests would be needed to identify individuals that breed true for nematode resistance from these families. Therefore, in future breeding of nematode resistant sugarbeets where only one side, whether male or female, is homozygous for resistance, only the first generation hybrids could be used as resistant commercial varieties. In parental line breeding and development after the F_1 generation, it would again be necessary to use progeny testing to identify true-breeding individuals.

Table 1. Transmission of nematode resistance of progeny from resistant homozygous sugarbeets 3552 and 3584.

Source	Cross[1/]	No. of plants tested Total	NR	NS	Remarks
3552	808 ⊗	16	16	-	
	809 ⊗	23	23	-	
	810 ⊗	2	2	-	Seed set was poor
3584	726 ⊗	20	20	-	
	731 ⊗	6	6	-	One NR plant had tall growth profile
	733 ⊗	8	8	-	
	733 O.P.	11	11	-	
	737 ⊗	8	8	-	
	743 ⊗	3	3	-	
	744 ⊗	8	8	-	
	745 ⊗	6	6	-	
	747 ⊗	9	9	-	
	749 ⊗	9	9	-	
	750 ⊗	6	6	-	
	751 ⊗	11	11	-	
	755 ⊗	5	4	1	The NS plant had 16 cysts
	755 O.P.	28	28	-	
	759 ⊗	10	9	1	The NS plant had 20 cysts
	765 ⊗	19	18	1	The NS plant had 24 cysts
	766 ⊗	12	12	-	
	767 ⊗	9	9	-	
	768 ⊗	5	5	-	
	770 ⊗	9	9	-	
	770 O.P.	41	40	1	The NS plant had 11 cysts; one NR plant had red hypocotyl
	771 ⊗	14	14	-	
	775 ⊗	6	5	1	The NS plant had 15 cysts & red hypocotyl
	778 O.P.	2	2	-	
		306	301 (98.4%)	5	
3584[2/]	776 ⊗	76	35	41	Abundance of cysts on the roots of most NS plants
	783 ⊗	94	43	51	
		170	78 (45.9%)	92	

1/ ⊗ = self-pollinated, progenies showed some degrees of inbreeding depression; O.P. = open-pollinated.

2/ Plant No. 776 (red hypocotyl) and No. 783 (erect petioles) were heterozygous for the resistance, probably as a result of pollen contamination.

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

In 1980 the nematode-resistance transmission from F_2 to the F_3 generations was studied in self-sterile and in self-fertile hybrids. The main purpose of these investigations was the detection of homozygous nematode-resistant plants that transmit resistance to all their offspring. Homozygous nematode-resistant plants may be detected in the F_3 and in all following generations. To study nematode-resistance transmission, 563 F_3 plants from 25 F_2 self-fertile populations were tested. Transmission of resistance to the F_3 was higher than to the F_2 generation and varied in self-fertile populations from 33 to 65%. The average transmission rate was 60%. However, no homozygous resistant plants were detected in F_3 self-fertile populations. From 32 F_2 self-sterile populations, 1,477 F_3 plants were tested for resistance. The transmission rate in the F_3 generation varied from 33 to 53%. The majority of the F_2 populations transmitted resistance to 38-49% of the F_3 plants.

Two F_3 homozygous self-sterile nematode-resistant plants were selected and pollinated by nematode-resistant heterozygotes. The first homozygous plant transmitted resistance to 100% of the F_1 offspring and to 88% of the reciprocal cross. The second homozygous plant transmitted resistance to 100% of its offspring and also to the reciprocal cross. Work is now being concentrated on the development of homozygous nematode-resistant lines from these two nematode-resistant plants. All F_1 resistant plants obtained from this hybridization are now at different stages of experimentation. Some plants are being exposed to thermal induction, some have been crossed, and some F_2 progenies have already been tested for resistance.

Two methods are used to produce homozygous nematode-resistant lines. (1) Intercrosses are made between F_1 plants to maintain and increase the basic group of homozygous and heterozygous F_1 plants that transmit resistance to 100% of the F_2 offspring. From these plants new homozygous lines can be obtained. (2) Resistant F_1 plants are pollinated by nematode-susceptible plants followed by the hybridization of those F_1 plants that transmitted resistance to 100% of their F_2 progenies.

Cytological investigations and the study of nematode-resistance transmission in diploid nematode-resistant hybrids indicate that very few homozygous nematode-resistant plants will appear in F_1 hybrids derived from hybridization of homozygous and heterozygous resistant plants. This is caused by the inadequate transmission of resistance by female and especially by male gametes from resistant heterozygotes.

Investigation of transmission of nematode resistance in F_1 hybrids derived from hybridization of homozygous and heterozygous resistant plants .

Some F_1 plants derived from the first and second homozygous plants and their reciprocal crosses were intercrossed. Others were pollinated by nematode susceptible plants. In the group of intercrossed plants the progenies of 49 F_1 plants from the first homozygous plant and the progenies of 16 F_1 plants from the second homozygous plant were tested for resistance. Of the 49 F_1 plants, 14.3% transmitted resistance to all their offspring. Of the 16 F_1 plants from the second homozygous plant, 56.3% transmitted resistance to all their offspring. From the group of plants crossed with nematode susceptible plants, progenies of susceptible and resistant plants were tested for resistance. Of 77 F_1 hybrids from the first homozygous plant, 28.6% transmitted resistance to all their offspring. Of the 34 F_1 plants from the second homozygous plant, 55.9% transmitted resistance to 100% of their offspring. The rate of resistance transmission was much higher in the F_1 plants derived from the second homozygous resistant plant. Probably the B. procumbens segment in these plants was shortened and this facilitated the transmission of the chromosome bearing the B. procumbens segment.

Two homozygous resistant plants and two plants of their reciprocal crosses that transmitted resistance to 100% of the F_1 offspring were detected last year. Experiments conducted with F_1 plants derived from those plants with 100% resistance transmission resulted in a considerable increase in the number of plants that transmitted resistance to 100% of the F_2 offspring. The F_2 plants derived from plants with 100% resistance transmission after intercrossing of F_1 plants will be crossed with each other to maintain a population from which many new homozygous resistant plants can be selected.

Some F_1 plants transmitted resistance to 80 and 90% of the F_2 offspring. These F_2 progenies, together with the F_2 progenies derived from F_1 hybrids with lower transmission rates were eliminated. The F_1 plants that transmitted resistance to 100% of the offspring of susceptible plant hybrids will be crossed for production of homozygous nematode-resistant lines.

The results of investigations conducted in 1980 indicate that some nematode-resistant lines can be released in 1981.

SUGARBEET RESEARCH

1980 Report

Section B

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CONTENTS

I. EXPERIMENTAL FIELD TRIALS

J. C. Theurer & D. L. Doney

Agronomic Data

Soil Types:	North Farm - silty loam Farmington Farm - sandy
Fertilizer:	950 lbs/acre of 16-20-0
Planting Dates:	Farmington Farm - April 17 and 18 North Farm - May 2
Note:	Chemical treatment for weed control was not made on any experimental plots in 1980. This was because of the toxicity of Nortron on the sugarbeet experiments and also on cereal grain crops following sugarbeets during the 1978 and 1979 growing seasons.
Thinning Dates:	North Farm - June 4 to 6 Farmington Farm - May 16 to 20
Irrigations:	Sprinkler irrigated at both farms until two weeks prior to harvest
Harvest Dates:	North Farm - October 9 to 10 Farmington Farm - September 20 to 30
Harvesting Procedures:	Tops were removed by beating twice with a rotobeater then topped and dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each two-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

A. COMMERCIAL VARIETY TEST

Fifteen commercial hybrid cultivars, USS2/3, and five Logan experimental varieties were planted at the North Farm in six replications. Individual plots were two rows, 22 inches apart, and 40 feet long. An excellent stand was observed for almost all plots and very few plants showed any curly top. Yield, sucrose percentage, and quality factors are listed in Table 1. GW77MSH122 had the greatest gross sugar of all entries. GW73, ACH130, and Bush Monofort were also significantly higher in gross sugar than GWD2, which we have used as a high yield check for several past years. USH11 and US22/3 were the only varieties having significantly less gross sugar than GWD2. The experiment line, g237, which is an open-pollinated selection out of our selection methods program, was the best Logan experimental variety. However, other experimentals were not different in sugar yield than GWD2, UI8, AH10, or AH14. GW77MSH122, ACH130,

and g237 were high tonnage varieties. UI8, Hilleshog, Monorica, Bush Monofort, and ACH31 were the varieties having the highest sugar percentage.

The experiment hybrid, h237, had significantly the poorest quality as indicated by a high index score of 707. GW77MSH122, the high yield hybrid, also had poor quality. UI8, Bush Monofort, Hilleshog Monoricca, and the other Logan experimental hybrids were good for quality factors.

Table 1. Root yield, sucrose percentage, and impurity factors for commercial and experimental hybrids, Logan, Utah, 1980.

Variety	Gross Sugar Lb/A	Root Yield T/A	% Sugar	N ppm	K ppm	Na ppm	Index
GW77MSH122	8904	27.5	16.1	529	1629	228	631
Bush Monofort	8775	25.3	17.3	321	1412	278	437
GW73	8646	25.8	16.8	404	1327	210	483
ACH130	8638	26.6	16.2	389	1566	293	545
GWR1	8528	25.5	16.7	422	1295	148	480
g237	8522	26.4	16.1	513	1939	390	707
Beta40619	8433	25.9	16.3	436	1677	233	576
Hilleshog Monoricca	8276	23.2	17.8	342	1329	324	444
ACH31	8129	23.8	17.1	387	1331	285	482
UI8	7972	22.4	17.8	331	1360	236	424
GWD2	7859	24.1	16.3	424	1518	159	528
71181	7811	23.3	16.8	374	1179	273	455
HH28	7738	24.2	16.0	367	1427	200	498
USH20	7675	23.9	16.0	434	1354	298	547
AH14	7574	23.4	16.2	408	1558	234	544
41285	7427	22.2	16.6	307	947	199	370
AH10	7390	22.7	16.3	484	1516	195	574
71183	7312	22.1	16.6	338	1095	230	419
0459	7217	22.2	16.3	343	1129	167	425
US22/3	7066	21.5	16.4	457	1606	236	577
USH11	6889	22.4	15.4	397	1591	190	563
LSD .05	740	2.03	0.6	95	258	69	82
F	5.31	5.55	7.61	3.23	5.90	5.63	7.45
C.V.	8.2	7.4	3.3	20.8	16.0	25.5	14.2
Mean	7949	24.0	16.5	400	1418	239	510

B. FIELD TEST - NEW LINES

Several promising new lines and hybrids have been generated over the past few years from our selection methods research. A number of these lines and hybrids were tested in a replicated field trial with some of the best commercial hybrids of the intermountain area (Table 2).

Table 2. Yield, sugar content, and impurity data for new lines, new hybrids, and several commercial hybrids.

Variety	Gross Sugar Lb/A	Root Yield G/A	Sugar %	N ppm	K ppm	Na ppm	Index	Root No
g232	6850	20.95	16.35	279	1987	306	541	64
g234	6826	20.92	16.31	276	1760	306	506	60
g235	7250	21.94	16.52	262	1606	279	463	73
g236	6618	19.96	16.58	248	1839	326	495	60
g237	7372	21.60	17.07	238	1687	289	446	70
g238	6206	19.14	16.22	336	1954	319	581	57
g239	6429	19.56	16.43	312	1950	305	552	59
g242	5816	17.30	16.97	327	2158	343	620	50
g246	5449	18.97	14.37	206	1802	301	542	55
g247	6946	21.60	16.08	238	1804	286	491	58
28D22	7047	21.31	16.53	276	1443	288	448	67
g228	6069	19.27	15.75	225	1739	203	466	58
g229	6148	18.89	16.27	305	1827	301	535	71
h8	6858	21.05	16.29	296	1808	335	532	72
UI8	6717	20.08	16.72	242	1410	193	396	71
f354	7142	21.79	16.39	271	1756	306	498	65
i75	6809	20.95	16.25	193	1447	196	385	70
i76	5992	18.71	16.02	281	1768	179	521	65
GWD2	8025	23.44	17.12	238	1670	155	414	78
AH10	7900	23.99	16.47	198	1322	171	359	79
28E32	6158	20.45	15.06	211	1850	268	512	72
28E44	8400	22.90	18.34	249	1758	236	422	77
28E49	7142	21.10	16.92	277	1718	303	480	74
28E54	6845	21.50	16.92	301	1862	231	532	62
LSD (0.05)	815	2.40	0.83	73	274	94	91	10
F	3.31	2.80	5.89	2.24	3.74	2.79	3.76	4.53
C.V.	11.2	10.0	4.5	24.2	14.0	30.8	16.4	14.0

Open-pollinated selections have a letter as the first digit in their code, whereas hybrids have a numeral as the first digit.

Of the open-pollinated lines, g237 and g235 are the most promising (Table 2). These are sister lines generated from a root yield and specific gravity selection method. Line g237 has been tested in seven field trials over the past four years in which hybrids UI8 and AH10 were also entered. The mean result of these seven tests is shown in Table 3. This line shows promise as a future breeding line.

Lines g232 and h8 are selections from our hypocotyl diameter selection method. Line g232 has been tested in four replicated field trials between 1977 and 1980, in which hybrids UI8 and AH10 were also present. The mean of the four tests

for g232, UI8, and AH10 are given in Table 4. This line shows some promise; however, it has a lower than acceptable sucrose content. The hypocotyl diameter selection method has been shown to increase yield but at the expense of a reduced sucrose content. This selection exhibits a similar selection response.

The most promising hybrid appears to be 28E44 (Table 2). It has a good root yield and a very high sucrose content. This hybrid has not been tested previously, however, these results suggest additional testing.

Table 3. Root yield, sucrose content and yield for g237, AH10 and UI8 summed over seven tests conducted in the years 1977 and 1980.

Variety	Total Sucrose Lbs/A	Root Yield T/A	Sucrose %
g237	8229	25.64	16.10
UI8	7935	24.33	16.35
AH10	7726	24.28	15.88

Table 4. Root yield, sucrose content, and total sucrose for g232, UI8, and AH10, summed over four tests between 1977 and 1980.

Variety	Total Sucrose Lbs/A	Root Yield T/A	Sucrose %
g232	7544	24.48	15.41
UI8	7697	23.92	16.08
AH10	7677	24.03	15.87

C. FIELD TEST OF OLD HIGH YIELD HYBRIDS

Twenty-two experimental varieties that had shown good sugar yield for at least one or two years at one or more locations were re-evaluated for their gross sugar yield. Not only were we interested in gross sugar per se, this value also would represent the amount of fermentable sugar that would be available for alcohol fuel production with no concern as the amount of impurities of a variety.

GWD2 and AH14 commercial varieties were planted as checks. Individual plots in the trial consisted of two 56-cm (22 inches) rows, approximately 12 meters (40 feet) long. The entire plot was harvested to determine yield, sugar percentage, and quality factors. Data of this test are given in Table 5.

Table 5. Root, yield, sucrose percentage, and impurity factors for re-evaluation of old Logan hybrids, North Farm, Logan, Utah, 1980.

Variety	Gross Sugar dt/ha	Root Weight t/ha	Sugar %	Amino N	Sodium ppm	Potassium ppm	Index
GWD2	91.89	56.73	16.20	478	236	1477	574
AH14	87.30	55.29	15.80	471	308	1560	615
L29X630+a	84.17	51.11	16.48	378	220	1116	447
L6X631+a	73.87	44.98	16.41	395	212	1227	473
L8X50+10	78.06	47.65	16.40	381	175	1195	453
L8X50+10	77.62	47.85	16.19	442	210	1568	563
(L27XL29)XL5)XL10	89.22	53.86	16.58	392	268	1002	445
(L29XUS22)XL10	77.36	48.50	15.98	422	316	1343	544
(E131X030)XL10	88.81	53.20	16.71	477	385	1054	525
(E131XL9)XL10	92.20	56.08	16.44	444	291	1264	525
(L33XL29)XA7134	90.68	57.90	15.74	478	391	1347	608
(L29XOv1)X(L5X00.2)	86.54	52.62	16.48	419	198	1312	495
(L28XL19)X(L5X00.2)	86.01	50.27	17.13	443	179	1297	487
(L33X0198)X(L26X631)	82.55	51.51	16.03	427	288	1213	522
(L33XL5)XL37	92.07	56.92	16.16	522	215	1268	567
(FC601XL5)XL37	92.20	56.66	16.28	469	188	1433	550
(CMS9XL37)	102.22	63.39	16.13	507	354	1497	624
(E132X030)XL37	95.93	56.79	16.90	575	263	1502	617
(L12XC1)XA7135	87.72	55.42	15.83	493	288	1335	588
(L29XL20)XA7135	85.69	52.68	16.28	449	244	1212	518
L29XL38	92.13	57.71	15.99	440	255	1354	545
CMS9XL38	97.68	64.24	15.21	417	525	1733	681
(L9XL53)X9540	94.64	58.43	16.18	417	250	1433	533
(L29X)v2)XL19	89.29	49.68	17.99	415	179	1152	426
Mean	88.16	54.14	16.31	485	269	1330	539
LSD .05	7.88	4.65	0.57	75.76	101.59	192.24	71.88
C.V.	7.82	7.51	3.04	4.78	33.07	12.65	11.68

Only one variety, CMS9XL37, had significantly greater gross sugar than the GWD2 check. Two additional hybrids (E132X030)XL37 and CMS9XL38 were better than AH14. The two CMS9 hybrids were superior to GWD2 for root yield. All entries exceeded 15 percent sucrose percentage. Varieties with L19 as a parent were highest. Impurity index values ranged from 426 to 681. Seven entries were significantly lower in impurities than GWD2. CMS9X38 is a line having excellent sugar yield and rather poor quality, and thus would be more acceptable as a fuel beet than a variety for crystallized sugar production.

II. SELECTION FOR ROOT/LEAF RATIO

J. C. Theurer

Results of studies by F. W. Snyder, etal. have suggested that selections based on R/L ratio could be used to effectively improve sugarbeet production. Selections have been made in controlled greenhouse sandbenches at Logan in three different populations. However, seed of only one population has been produced in sufficient quantities to be field tested. This test was transplanted to the field a few years ago. The high R/T ratio selection was no better in yield than the parent but did show significant improvement in sucrose percentage.

In 1980, we established a field trial to compare the root/leaf ratio with different selection methods. All selections were made from a highly heterogeneous population, 6F3. Selections compared were: 1) two lines descending from individual plants selected for large hypocotyl diameter in the greenhouse (GH RD sel.), 2) a line selected in the field for large root/leaf ratio after 60 days growth (R/L E sel.), 3) a line selected for high root weight after 60 days growth (RW E sel.), and 4) a line selected for large root weight at harvest (RW MR sel.). The parent population, and two commercial sugarbeet varieties, GWD2 and AH10, were included as checks. The field plot consisted of two 56-cm (22 inches) wide rows, approximately 12 meters (40 feet) long, in four replications. The entire plot was harvested for yield and a sample taken for sugar determination. Results in Table 1 show that the 6F3 parent gave the greatest gross sugar. There is some self fertility in the parent population 6F3; therefore, inbreeding may account for some of the yield differences between the parent and the selections. The root weight selection after 60 days growth was the least productive in sugar yield with only 58 dt/ha. The early root/leaf ratio selection had the highest gross sugar of the selection lines which was mainly due to the high sugar percentage of this line. This again demonstrates the validity of R/L ratio as a selection method for increasing sucrose content.

Table 1. Root yield, sucrose percentage, and impurity factors for selections in population 6F3, Logan, Utah, 1980.

Variety	Gross Sugar dt/ha	Root Weight t/ha	Sugar %	Amino N ppm	Sodium ppm	Potassium ppm	Index
GWD2	74.17	46.67	15.90	336	136	1552	485
AH10	62.21	40.15	15.49	303	168	1697	508
R/L E Sel.	77.13	47.52	16.20	362	211	1810	549
RW E Sel.	58.04	36.75	15.79	362	299	1595	548
GH RD Sel.	74.69	47.72	15.65	280	363	1277	465
GH RD Sel.	65.47	42.95	15.23	443	357	1995	701
RW MR Sel.	74.23	46.48	15.98	352	229	1708	540
6F3 Parent	80.44	51.24	15.73	312	226	1641	511
Mean	70.80	44.94	15.74	344	249	1660	539
LSD .05	14.29	8.82	0.51	54.84	55.87	221.64	65.55
C.V.	17.22	16.76	2.74	13.59	19.14	1139	10.38

III. PHYSIOLOGICAL SELECTION

D. L. Doney

Cellular level investigations over the past two years have revealed an inverse relationship between cell size and sucrose content. This relationship is the physiological reason for the negative correlation between sucrose content and root yield which has significantly affected progress in increasing root yield while maintaining or increasing sucrose content.

Genetic studies suggested that increasing root yields while maintaining high sucrose content can be achieved by selection for fast cell-division rate rather than for large cell size. Unfortunately, many of the past selection methods for increasing root yield have capitalized on cell size, which in turn has resulted in higher root yields and lower sucrose concentration.

Counting and measuring cells is a very tedious and time consuming process and is impractical in a breeding program. If this new knowledge is to be useful to the plant breeder, methods to measure these cellular parameters must be developed that will be fast, accurate, and inexpensive. In our effort to develop practical methods to utilize these discoveries, we have looked at both electronic and alternate methods of measuring cellular parameters.

The coulter counter was found to be a very accurate and fast method of measuring cell size and cell number. A sample of about 20,000 cells can be counted and measured in about one to two minutes. However, this method has two drawbacks. First, the coulter counter is a very expensive, sophisticated piece of equipment, and second, the digestion of sugarbeet tissue samples to a homogeneous mixture of single cells has not been perfected.

Several alternate methods of selection have been investigated. These methods are fast, easy to measure, and relative inexpensive. These methods, along with their expected cellular and field effects, are listed in Table 1.

Table 1. Selection parameters and their expected effects on cellular parameters and field results.

Selection Parameter	Expected Cellular Effects	Expected Field Effects
Hypocotyl diameter at 21 days	Cell size and cell number (confounded)	Root yield and sucrose content (confounded)
Percent dry matter at 21 days	Cell size	Sucrose content
Total dry matter at 21 days	Total cell surface area (Cell size and cell number confounded)	Total sucrose (Yield and sucrose content confounded)
Hypocotyl diameter at 6 days	Cell size	Sucrose content

The expected effects are based on the following assumptions and rationale:

Assumptions:

1. Genetic differences in root yield are due to genetic differences in cell size and/or cell number.

2. Genetic differences in sucrose content are largely due to genetic differences in cell size (high sucrose = small cell size).

3. Hypocotyl or root diameter (HD) at 21 days is a relatively good measure of a genotype's potential root yield.

4. Little genetic difference exists for mean cell wall thickness.

5. Little genetic difference exists for the number of cortex cells at the time of emergence (6 days).

Rationale:

Hypocotyl diameter at 21 days has been shown to affect both cell size and cell number and generally results in larger root yields but lower sucrose contents.

At 21 days, there is very little sucrose and very little genetic differences in other soluble dry matter; therefore, differences in percent dry matter at 21 days are largely due to differences in fiber content. More cell surface area per volume is present with small cells than large cells. If there is no difference in cell wall thickness, higher percent dry matter at 21 days should result in smaller cell size.

We have found very few genetic differences in cortex cell number at 6 days. There are two important factors that affect cortex cell size: 1) seed quality, and 2) genetic difference. If seed quality can be controlled, then differences in HD at 6 days are largely due to differences in cortex cell size. Genetic differences in cell size in one organ are generally manifest in cells of other organs. Therefore, differences in HD of 6-day-old plants should give a relative measure of genetic differences in true root cell size.

Different combinations of these selection parameters should complement each other and result in the desired selection performance. For example, a selection with a small HD at 6 days and large HD at 21 days should have many small cells and result in high root yield and high percent sucrose. Unfortunately, these are difficult to find.

Selection Results

Selections for one or more of these parameters were made in several broadbase populations. Selections with sufficient seed were tested in the field in 1980.

Broadbase Population f1

A number of individual plants were selected for HD at 6 days from broadbase population f1. Sufficient seed was obtained from three plants (two with large HD at 6 days and one with small HD at 6 days) to test in the field.

The large HD selections were expected to have a low sucrose content, and both were lower than the f1 parent. The L91 selection was significantly lower than the parent with a sucrose content of 13.5 percent compared to 16.0 percent for the parent (Table 2). The small HD selection was expected to have a higher sucrose content. It was higher but not significantly higher than the parent. However, it was significantly higher than the large HD selection.

Table 2. The effect of HD selection at 6 days on sucrose percentage.

	Sucrose %	Expected Selection Effect
Parent (f1)	16.0	
i62 (large HD at 6 days)	15.5	low sucrose
L91 (large HD at 6 days)	13.5	low sucrose
L89 (small HD at 6 days)	16.3	high sucrose
LSD (0.05)	0.6	

Broadbase Population f354

Individual plants were selected for HD at 6 days and at 21 days in broadbase population f354. The selected plants were pooled into two polycrosses for seed increase: 1) small HD at 6 days and large HD at 21 days, and 2) small HD at 6 days and small HD at 21 days. These two polycrosses were tested in a replicated field trial along with the parent population (f354) in 1980. The small HD at 6 days and large HD at 21 days selection was expected to have high yield and high percent sucrose, whereas the small HD at 6 days and small HD at 21 days was expected to be low in yield and high in percent sucrose. However, neither selection differed from the parent population in sucrose content, root yield, or total sucrose (Table 3). There was, however, a significant difference in percent sucrose between the two selections.

At this point, it appears that the assumptions and rationale expressed earlier are incorrect. However, these selections were individual plants, and plants of this size are very susceptible to environmental variation. Either the environmental variation was so great that genetic differences could not be detected or the assumptions were not valid.

Table 3. Field results of single plant selection at 6 days and 21 days in broadbase population f354.

	Total Sucrose Lbs/A	Root Yield T/A	Sucrose %	Expected Selection Effect
Parent (f354)	7638	23.8	16.1	
164 (small HD at 6 days and large HD at 21 days)	7038	22.4	15.7	high sucrose high yield
192 (small HD at 6 days and small HD at 21 days)	7189	22.7	16.3	high sucrose low yield
LSD (0.05)	910	2.7	0.6	

Broadbase Population g237

Since progeny tests are more accurate and reliable than single plants for selection purposes, selection in this population was based on progeny tests. Individual plants were crossed to the same CMS tester and the resultant seed tested for HD at 6 days and percent dry matter at 21 days. Remnant seed of several crosses with the same characteristics were pooled to form four groups that were tested in a replicated field trial in 1980. Interestingly, some of these selection parameters contradicted each other. For example, Group I (GI) had large HD at 6 days and high percent dry matter at 21 days. Based on the selection parameter at 6 days, this group selection should have low percent sucrose; however, based on the selection parameter at 21 days, it should have a high percent sucrose (Table 4).

Table 4. The effect of progeny selection at 6 days and 21 days on sucrose content in broadbase population g237.

	Sucrose %	Expected field effects of selection at: 6 days	21 days
Parent (g237)	14.9		
GI Large HD at 6 days & high % dry matter at 21 days	15.4	Low % sucrose	High % sucrose
GII Small HD at 6 days & high % dry matter at 21 days	16.2	High % sucrose	High % sucrose
GIII Average HD at 6 days and average % dry matter at 21 days	14.8	% sucrose equal to parent	% sucrose equal to parent
GIV Large HD at 6 days & high % dry matter at 21 days	15.1	Low % sucrose	High % sucrose
LSD (0.05)	1.4		

Those selections with contradictory selection parameters (GI and GIV) had a sucrose content not different from the parent. The selection that was expected to have a sucrose content equal to the parent was not different from the parent, either (GIII). The only selection that showed an effect on sucrose content was where both selection parameters agreed (GII). This selection had a significantly higher sucrose content than the parent (Table 4). This points out the difficulty in detecting true genetic differences in young plants.

Broadbase Population h537

This is the most heterozygous of the populations used. Selection in this population was also based on progeny testing. Individual plants were planted in a polycross block, allowed to intercross, and seed was harvested on each plant separately. This half sib seed was used to evaluate each plant for the four seedling selection parameters mentioned above. Based on these seedling evaluations, several plants were selected as having different combinations of the selection parameters. Remnant seed of the selected plants were used for field testing in a replicated trial in 1980. At least two entries were tested for each selection parameter. All entries for a given selection parameter are combined in the following tables for comparison purposes.

Selection Parameters:

1. Percent dry weight at 21 days.

   Selections for high percent dry weight, low percent dry weight, and the parent are compared for percent sucrose in Table 5.

Table 5. Percent sucrose for selections differing in percent dry weight at 21 days and the parent.

Selection Parameter	Sucrose %	Expected Field Results
Parent (h537)	14.64	
High % dry weight	14.92	High percent sucrose
Low % dry weight	14.20	Low percent sucrose
LSD (0.05)	0.38	

The high % dry matter selection had a higher but not significant sucrose content than the parent. The low percent dry matter selection had a significantly lower sucrose concentration than the parent, and the two selections were significantly different from each other in the expected direction.

2. Hypocotyl diameter at 6 days.

   The results of selection for HD at 6 days is given in Table 6.

Table 6. Sucrose content of parent and selections for large and small HD at 6 days.

Selection Parameters	Sucrose %	Expected Field Results
Parent (h537)	14.64	
Small HD at 6 days	14.88	High percent sucrose
Large HD at 6 days	14.24	Low percent sucrose
LSD (0.05)	0.38	

The effect of selection for HD at 6 days on sucrose content was similar to but not as pronounced as the previous selection parameter (percent dry weight at 21 days). The small HD selection had a higher sucrose content and the large HD selection had a lower sucrose content than the parent as was expected. The two selections differed significantly in sucrose content and the large HD selection had a significantly lower sucrose content than the parent.

3. Combined HD at 6 days and percent dry weight at 21 days.

Both of these parameters are supposed to affect sucrose content. The two previous tables (Tables 5 and 6) suggested that they both influenced sucrose content with percent dry weight at 21 days being a more effective selection criterion. By combining both selection parameters, more effective selection resulted (Table 7).

Table 7. The effect of selection for HD at 6 days combined with percent dry matter at 21 days on sucrose content.

Selection Parameter	Sucrose %	Expected Field Result
Parent (h537)	14.64	
High percent dry weight at 21 days and Small HD at 6 days	14.99	High percent sucrose
Low percent dry weight at 21 days and Large HD at 6 days	13.97	Low percent sucrose
LSD (0.05)	0.45	

4. Hypocotyl diameter at 21 days.

We have previously reported the effects of selection for hypocotyl diameter at 21 days on root yield. Selection for HD at 21 days in this population resulted in similar results (Table 8). The large HD selection yielded more

but not significantly more than the parent, whereas the small HD selection yielded significantly less than the parent.

Table 8. The effect of HD selection at 21 days on root yield.

Selection Parameter	Root Yield T/A	Expected Field Results
Parent (h537)	32.82	
Large HD at 21 days	33.67	High root yield
Small HD at 21 days	29.11	Low root yield
LSD (0.05)	2.06	

5. Total dry matter at 21 days.

As was stated earlier, total dry matter in sugarbeet seedlings should be related to total sucrose production. Selections for high and low total dry matter at 21 days did differ significantly in total sucrose (Table 9). The high total dry matter selection yielded more but not significantly more total sucrose than the parent, whereas the low total dry matter selection yielded significantly less sucrose than the parent.

Table 9. The effect of selection for dry matter at 21 days on total sucrose production.

Selection Parameter	Total Sucrose Lbs/A	Expected Field Results
Parent (h537)	9609	
High total dry matter	9829	High total sucrose
Low total dry matter	8016	Low total sucrose
LSD (0.05)	581	

6. Hypocotyl diameter at 6 days and 21 days.

The most desirable combination of the seedling selection parameters is a small HD at 6 days and large HD at 21 days. There were very few lines with this particular combination. Only one selection had sufficient seed to field test. This selection, along with a selection having the opposite parameters, is compared in Table 10. The two selections differed significantly for sucrose content, root yield, and total sucrose production. This most desirable selection should be superior to the parent in all three field measurements. It was better than the parent for sucrose content and total sucrose but gave the same root yield as the parent.

Table 10. The effect of selection for HD at 6 days and 21 days on field date.

Selection Parameter	Sucrose %	Root Yield T/A	Total Sucrose Lbs/A	Expected Field Results
Parent (h537)	14.64	32.82	9609	
Small HD at 7 days and large HD at 21 days	15.02	32.78	9829	High sucrose content High root yield
Large HD at 6 days and small HD at 21 days	13.97	28.73	8016	Low sucrose content Low root yield
LSD (0.05)	0.45	2.51	711	

7. Small HD at 6 days, large HD at 21 days, and high total dry matter.

Only one selection exhibited all three of the above parameters. This selection gave the highest root yield and total sugar but was not different from the parent in sucrose content (Table 11).

Table 11. Root yield, sucrose percent, and total sucrose for a selection for HD at 6 and 21 days, and dry matter at 21 days, and its parent.

Selection Parameter	Sucrose %	Root Yield T/A	Total Sucrose Lbs/A
Parent (h537)	14.64	32.82	9609
Small HD at 7 days Large HD at 21 days and High dry weight at 21 days	14.66	35.24	10337
LSD (0.05)	0.45	2.52	711

Summary and Conclusions

The assumptions and rationale developed in this study appear to be valid. The fact that selection was more effective using progeny tests than with individual plants indicate the difficulty in detecting genetic differences in individual plants. Small plants are very susceptible to environmental variation and every effort must be made to control it. The effectiveness of selection for an alternate trait depends on the relative magnitude of the environmental and genetic variances and correlations. In selecting an alternate trait of an alternate trait, probabilities are multiplied, thus reducing the probability of detecting true genetic differences of the desired characters. In this case, our goal is to increase root yield while maintaining or increasing sucrose content. Selection for an alternate trait that affects cellular parameters, which in turn affect root yield and sucrose content, will be effective only if

the heritabilities of the alternate traits are greater than the heritabilities of root yield and sucrose content, and if they are more easily and quickly measured. The alternate traits measured in this study meet the last two criteria, and the fact that differences in the desired, expected directions were obtained suggests that desirable heritabilities are present in the alternate traits. In most cases, selection to reduce root yield or sucrose content was more effective than selection to improve root yield or sucrose content. Apparently our current hybrids are using a significant amount of the available superior germplasm, and future improvement will be in small increments rather than large jumps. This points out the need for refined, highly controlled selection techniques to detect the small superior genetic differences. The results of this study are encouraging and warrant further research, especially in the refinement and precision of these seedling selection methods.

IV. GROWTH ANALYSIS

D. L. Doney and J. C. Theurer

A. GENOTYPE VS. PLANT DENSITY

Methods and Materials

This test was planted at two plant densities (22- and 14.6-inch row widths) to evaluate the effect of row width on genotypes differing widely in sugar content and yield. Genotypes planted were:

1. Good commercial hybrid sugarbeet (GWD2).
2. High root yield-small top sugarbeet inbred (L10).
3. High sucrose content sugarbeet inbred (L19).
4. High root and top yield sugarbeet inbred (C17).
5. Sugar X fodder beet hybrids (Monorosa, Cimarosa, and Kyros).
6. Large root yield fodder beet (Peramono).

The plot design was a split-plot of eight replicates. Plots were six rows (14.7-inch row width) and four rows (22-inch row width), 40 feet in length. One hundred fifty pounds actual N were broadcast prior to planting as 16-20-0 fertilizer. The experimental plot had been fallowed in 1978 and 1979 and apparently much of the available N had been leached from the soil. A severe nitrogen deficiency appeared in mid August.

The test trial was planted April 17, thinned May 22, and harvested September 30. Heavy rains followed thinning and caused some root rot and damping off. Although most plants recovered, many were retarded, particularly in genotype L19. Satisfactory stands were obtained in the sugarbeet lines; however, stands were significantly reduced in the fodder beet lines Cimarosa, Peramono, and Kyros. Some curly top was detected in the fodder beet lines in mid season but was insufficient to cause a significant effect (results found in Table 1).

Results

Sugars

Sucrose content ranged from about 20 to 8.5 percent. The fodder beets were much lower in sucrose than the sugarbeets. There were no significant differences in sucrose content in the two plant densities and no genotype by plant density interaction. Reducing sugars were inversely correlated with sucrose content; however, the difference between the highest and lowest was only about one-fourth of one percent.

Root Yield

The fodder beets yielded significantly more than the sugarbeets and appeared to respond more to increased plant density than the vigorous sugarbeets (GWD2 and C17). The less vigorous inbreds (L10 and L19) increased in yield at the higher plant density as did the fodder beet Peramono. A significant increase

in root yield was obtained at the higher plant density when summing over all genotypes, even though genotype GWD2 decreased slightly at the higher plant density. This resulted in a significant genotype by plant density interaction.

Total Fermentable Sugars

The effect of plant density on total sugars was very similar to the effect of plant density on root yield since there were no plant density effects on sugar content. The fodder beets did not yield as much total fermentable sugars as the best sugarbeet hybrid (GWD2), although Cimarosa's sugar yield was almost as good as GWD2.

Impurities

Sodium content was unaffected by plant density and potassium content was significantly reduced in the high plant density. Even though all genotypes experienced some reduction in potassium content at the high plant density, none was significant. The fodder beet lines had significantly more sodium and potassium than the sugarbeet lines. This was expected since the sugarbeet lines have been selected for low impurities.

Summary

The response to differences in plant density was less pronounced in the 1980 competition trial than the similar competition trial in 1979. Low fertility in the 1980 trial appeared to be a major limiting factor. Therefore, plants could not take advantage of their allocated space to the maximum of their ability. The same relationship exists, i.e., the less vigorous inbreds responded more than the more vigorous hybrids to plant density; however, this response was not as great as in the 1979 trial. The fodder beets appeared to respond more to increased plant density than the sugarbeets. This apparent difference should be further investigated at higher fertility levels.

Table 1. Sugar contents, yields, and impurity contents for a sugarbeet hybrid, high sugar, and high root yield inbreds, and four fodder beets at 2-row spacings.

Variety	% Sucrose		% Reducing Sugar		Root Yield T/A		Total Fermentable Sugars		Sodium ppm		Potassium ppm		Stand Density	
	22"	14.7"	22"	14.7"	22"	14.7"	22"	14.6"	22"	14.6"	22"	14.6"	22"	14.6"
GWD2	18.00	17.49	.142	.151	24.41	24.12	8845	8492	109	132	1702	1600	29460	44250
L10	17.37	17.27	.141	.132	20.61	22.03	7197	7665	170	181	1248	1253	29700	42470
L19	19.52	19.88	.210	.201	12.71	14.43	5014	5781	172	168	1842	1653	25540	39500
C17	17.36	17.20	.148	.122	23.08	23.38	8100	8091	109	124	1527	1570	27320	44250
Monorosa	13.79	14.14	.222	.185	27.18	28.07	7579	8059	434	417	2273	2063	28800	41870
Cimarosa	14.72	14.81	.164	.154	27.81	28.81	8217	8619	377	329	2117	2058	21090	31185
Peramono	8.74	8.66	.412	.436	27.18	32.08	5014	5820	801	815	2625	2513	20200	32970
Kyros	11.66	11.82	.352	.321	30.58	30.92	7314	7494	465	517	2210	2092	20790	30590
LSD 0.05	0.72	0.72	.052	.052	3.84	3.84	1017	1017	64	64	124	124	4454	4454
Mean	15.15	15.16	.224	.213	24.19[a]	25.48[b]	7160[a]	7503[b]	330	335	1943[a]	1850[b]	25360[a]	38390[b]
Variety X Plant Density	ns	ns	ns	ns	*	*	*	*	ns	ns	ns	ns	ns	ns

* = Significant variety X plant density interaction.

Note: Means followed by different letters are significantly different.

B. SUGARBEET HYBRID GENOTYPES VS. PLANT DENSITY

Yields of corn hybrids have been increased by altering the plant population and selecting genotypes that perform well under higher plant densities. This study was initiated to determine what effect plant density would have on high yield and high sucrose genotypes of sugarbeet hybrids.

Materials and Methods

Four hybrids were evaluated for their production at three different plant densities. The varieties included in the test were the commercial varieties GWD2 and ACH130, the experimental high sugar variety LHS-3, and LHY-1, a high yield variety. The test was planted on university land six miles south of Logan on June 11. This was a month later than we would normally plant. However, due to rain during the month of May, we were not able to get onto the land until the second week of June. The design was a split plot of five replications. The individual plots were 88 inches wide and 30 feet long. Plants were thinned to 12 inches between beets within the row in all plantings. Distances between rows were 13.2, 16.5, and 22 inches for the respective densities of approximately: 1) 35,600, 2) 29,700, and 3) 23,700 plants per acre. Excellent stands were attained for each plot and very little curly top was observed in the test. Harvest was made on September 18, 1980. All border rows of each plot and a 2-foot area next to the alleyway were excluded from the harvest area of each plot.

Results

Root Yield

The high sugar hybrid LHS-3 was significantly lower in root yield than the three other entries at the normal 4-row, 22-inch spacing (Table 2). There were no differences between varieties in root yield at the higher plant densities. On the average, the 16.5-inch spacing showed significantly greater root weight than the 13.2-inch spacing, and approached significance in comparison with the 22-inch row spacing. LHS-3 was significantly higher in root yield at the 16.5-inch spacing than at either 22- or 13.2-inch row densities.

Sugar

As expected, the LHS-3 hybrid had significantly higher sucrose percentage than the other hybrids at all three planting densities. With the exception of LHY-1 at the 16.5-inch row spacing, ACH130 had significantly the lowest sucrose percentage. There were no real differences in sucrose content due to plant density.

Gross Sugar Yield

Gross sugar was the main constituent we were interested in measuring. It is evident from the data that there were interactions of genotypes and planting

densities.

Table 2. Root yield, sucrose percentage, and impurity factors for four varieties at 35,600, 29,700, and 23,700 plant densities, South Farm, Logan, Utah, 1980.

Variety	Row Spacing	Root Fresh t/ha	Sucrose %	Gross Sugar dt/ha	Amino ppm	Potassium ppm	Sodium ppm	Index
GWD2	4-rows	38.64	16.07	61.95	378	1737	207	552
ACH130	22"	38.09	15.36	58.43	291	1815	322	559
LHY-1		39.93	16.32	65.39	328	1360	291	475
LHS-3		33.51	17.18	57.63	317	1720	273	490
Mean		37.54	16.23	60.85	329	1658	273	519
GWD2	5-rows	40.51	16.33	66.10	344	1815	195	530
ACH130	16.5"	37.48	15.68	58.78	262	1785	283	515
LHY-1		40.74	16.30	66.43	312	1292	293	452
LHS-3		39.72	17.80	69.25	278	1697	222	439
Mean		39.61	16.53	65.14	299	1647	248	484
GWD2	6-rows	38.27	16.69	63.79	276	1685	183	456
ACH130	13.2"	35.89	15.35	55.17	250	1795	213	529
LHY-1		38.97	16.20	63.21	250	1190	259	394
LHS-3		35.04	17.51	61.32	265	1580	219	421
Mean		37.04	16.44	60.87	260	1563	219	450
Overall Mean		38.00	16.40	62.21	296	1623	255	485
LSD .05 (varieties)		4.32	0.64	7.04	62	271	64	83
LSD (0.05) (between row spacing)		2.16	0.32	3.52	31	136	33	42
C.V.		8.89	3.06	8.84	16.49	13.09	19.81	13.43

The 5-row plots averaged significantly higher gross sugar than 4- or 6-row densities. There was little difference between the gross sugar yield of GWD2 and LHY-1 at any of the planting densities. ACH130 yielded significantly less gross sugar than GWD2 or LHY-1 at the 16.5- and 13.2-inch densities. The LHS-3 hybrid at the 5-row density gave the greatest sugar yield in the test, 69.25 dt/ha. The gross sugar for this hybrid was significantly better at the 5-row spacing than at either 4- or 6-row densities.

Quality Factors

There was a definite trend wherein impurity constituents decreased as the planting density increased from the 22- to 13.2-inch row spacing. The 6-row plots had significantly less amino N, sodium content, and lower impurity index values than the 4-row normal row spacing. ACH130 was significantly lower in amino N than GWD2 at both the 22- and 16.5-inch densities. LHY-1

was significantly lower in potassium than the three other genotypes at all spacings. LHY-1 had the lowest impurity index values and ACH130 had the highest.

Summary

Based on this data, it would appear that the 5-row, 16.5-inch plant density was superior to the standard 4-row, 22-inch density. High sugar lines in particular could possibly yield more gross sugar with a greater plant density than the currently used 22-inch row spacing. With the short growing season, the competition between plants at higher plant densities didn't give opportunity for maximum competition expression, as would be realized with a full seasons growth. The experiment needs to be repeated to confirm these conclusions.

C. THE EFFECT OF FERTILIZER AND MOISTURE

This was a cooperative study with Dr. John Carter (USDA-SEA-AR Agronomist, Kimberly, Idaho). This test was designed to determine the relative effect of nitrogen level and water level on genotypes with extreme genetic differences in root yield and sucrose content. The test entries and their characteristics are listed in Table 3 and included sugarbeet hybrids as well as fodder beets.

Table 3. Test entries and description.

Variety	Description
GW-Mono-Hy-D2	Commercial hybrid variety Great Western Sugar Co.
AH10	Commercial hybrid sugarbeet variety Amalgamated Sugar Co.
LHY-1	Logan high yield experimental variety
LHS-1	Logan high sucrose content experimental variety
Monorosa	Diploid high yield hybrid fodder beet (2n sugarbeet X 2n fodder beet)
Pajbjerg Korsroe P.	Polyploid high yield fodder beet
Rota	Diploid open-pollinated variety fodder beet
Monoblanc	Triploid high yield hybrid fodder beet (2n sugarbeet X 4n fodder beet)

It was planted April 8, 1980, at the Kimberly research station in a randomized split-split plot design. Soil moisture and seedbed preparation were excellent, resulting in almost perfect stands. There were two nitrogen and two water level treatments as follows:

LN-NW = normal nitrogen and normal irrigation
LN-SW = normal nitrogen and stress irrigation
HN-NW = high nitrogen (2 X normal) and normal irrigation
HN-SW = high nitrogen (2 X normal) and stress irrigation

The systemic insecticide temik was applied prior to planting to help control curly top in the susceptible fodder beet lines. Fortunately, 1980 was a low curly top year and very little curly top was observed in the plots. Plots were four, 25-foot rows. At harvest time (October 14 to 17), three, 10-foot samples were taken from each plot for measurements and analysis. The water stress treatments were watered normally until the early part of August, after which no supplemental irrigation was applied.

The only data available at this time is from the normal irrigation plots. However, preliminary data indicate little effect due to water stress.

All entries responded to the high nitrogen level (Table 4). The sugarbeet hybrids had a higher root yield but lower sucrose content at the high nitrogen level. The end result was very little difference in total fermentable sugars and potential alcohol yield between the normal and high nitrogen levels for the sugarbeet hybrids. The Monorosa and Monoblanc fodder beets are in reality sugarbeet-fodder beet hybrids and they responded to the different nitrogen levels similar to the sugarbeet hybrids, i.e., the increase in root yield and decrease in sucrose content at the high nitrogen level offset each other, resulting in little nitrogen level effects on total fermentable sugar and potential alcohol yield.

The fodder beet lines, Pajbjerg Korsroe P. and Rota, are true fodder beets and responded differently to high nitrogen. The high nitrogen level caused a significant increase in root yield in these two fodder beet lines. They did experience a decrease in sucrose content at high nitrogen, but not as extensive as the sugarbeets. The decrease in sucrose content did not offset the significant root yield and resulted in significantly more fermentable sugar and potential alcohol per acre at the high nitrogen level.

Even though the fodder beets yielded more than the sugarbeets (almost twice as much), their sucrose content was lower and did not yield more total fermentable sugar or potential alcohol than the best sugarbeet hybrids. The Logan experimental sugarbeet hybrid, LHY-1, and the fodder beet, Pajbjerg Korsroe P., yielded the most fermentable sugar with a potential alcohol yield of over 1,000 gallons per acre.

Table 4. Yields, sugar content, and potential alcohol for four sugarbeet hybrids and four fodder beets at two nitrogen levels.

Genotype	Nitrogen	Root Yield t/ha	Sucrose %	Reducing Sugars %	Total Fermentable Sugars t/ha	Potential Alcohol Gal/A*	Root Dry Weight %	Root Dry Weight Total t/ha
GWD2	X	83.11	18.2	0.138	15.25	971	23.84	19.81
	2X	88.96	17.2	0.151	15.42	981	23.15	20.59
AH10	X	76.05	18.3	0.165	14.03	894	24.88	19.92
	2X	83.76	16.6	0.158	14.03	894	23.14	19.38
LHY-1	X	85.06	18.6	0.163	15.96	1017	24.75	21.05
	2X	89.03	17.6	0.147	15.81	1007	23.37	20.81
LHS-1	X	68.74	20.6	0.158	14.26	908	27.30	18.77
	2X	77.37	18.7	0.186	14.62	931	24.89	19.26
Monorosa	X	92.86	15.2	0.136	14.24	907	20.66	19.18
	2X	104.34	13.8	0.145	14.55	927	19.23	20.07
Pajbjerg Korsroe P.	X	122.12	11.3	0.412	14.39	917	15.95	19.48
	2X	141.76	10.8	0.397	15.90	1013	15.90	22.54
Rota	X	118.33	9.9	0.349	12.15	774	13.90	16.45
	2X	142.34	8.8	0.358	13.09	834	13.32	18.96
Monoblanc	X	109.14	14.2	0.166	15.67	998	18.99	20.73
	2X	115.44	12.8	0.223	15.04	958	17.63	20.35

*Based on 85 percent conversion rate of 14.0 lbs sugar per gallon alcohol.

V. INSECT STUDIES

SELECTION FOR RESISTANCE TO THE SUGARBEET ROOT MAGGOT

J. C. Theurer, C. C. Blickenstaff, and D. L. Doney

The root maggot resistance program was continued in 1980 in cooperation with entomologists stationed at the Snake River Conservation Research Laboratory at Kimberly, Idaho. Seed from selections and crosses made in the greenhouse at Logan during the winter of 1979-80 were sent to Dr. Blickenstaff and were planted from May 2 to 5 at Kimberly. Seeds were hand planted one foot apart in 10-foot rows, spaced 22 inches apart and thinned to one plant per "hill" after emergence. Local fly populations were supplemented by flies trapped north of Paul, Idaho.

On July 17 to 21, plants were hand dug and rated individually on a scale of 0 to 9 (0 = no damage, to 9 = dead or severely damaged). Vigor ratings were made on June 12 and July 2 on a scale of 1 to 3 (1 = vigorous, 2 = average or normal, and 3 = weak). The percent of plants infected with curly top was also noted.

Section I

This section included high and low damage selections made in 1979 from the heterogeneous 35F3 population, the original 35F3 parent, and L19, an inbred check. A randomized design of 17 replicates of single-row plots was used in the test. This was the second cycle evaluation of high and low damage selections from this population. Results are summarized in Table 1.

Table 1. Performance of progeny of 1979 selections from 35F3 populations, Section I, 1980.

Seed No.	Description	Vigor July 10	Vigor July 2	Percent Plants With Curly Top	SBRM Mean Damage	% of Parent
40I13	Low damage	2.59b[1/]	2.1	3.3	1.43a	91
40I14	High damage	1.82a	2.0	1.8	2.05c	130
35G3	Parent	1.94a	2.0	1.2	1.58ab	
L19	Check	2.35b	2.1	7.1	1.94bc	
F. Value		7.11**	ns		4.76**	

[1/] Means with different letters are significantly different at .05 level.

The low-damage selection had a mean SBRM score of 1.43, which was better but not significantly better than the rating given the parent population. In 1980,

the low-damage selection showed only 9 percent improvement over the parent. By comparison, the first cycle of selection in 1979 resulted in an 18 percent reduction in maggot damage compared to the parent population. Thus, selection was ineffective in the second selection cycle in population 35F3. The low-damage selection also had less early vigor and more curly top damage.

Section II

This section included high and low damage selections made in 1979 from population 25A2, the 25A2 parent, and the high-damage L19 inbred check. This was an evaluation of the fifth cycle of selection from this population. Plots were single rows of 20 replications in a randomized block design. Excellent progress has been attained with the low-damage selection having significantly less damage than the parent (Table 2). Continual progress has been made in each cycle of selection from 1976 to the present (Table 3). The low-damage selection in the fifth cycle was 24 percent better than the original population.

Table 2. Performance of progeny of 1979 selections from 25A2 population, Section II, 1980.

Seed No.	Description	Vigor June 10	Vigor July 2	Percent Plants With Curly Top	SBRM Mean Damage	% of Parent
40I15	Low damage	2.30	2.0	0	1.51a[1/]	76
40I10	High damage	2.35	2.1	0	2.65c	133
25A2	Parent	2.40	2.0	0.5	2.00b	
L19	Check	2.00	2.0	7.8	2.44c	
F. Value		ns	ns		17.16**	

1/ Means with different letters are significantly different at .05 level.

Section III

In 1980, field evaluations were made of several F_1 hybrids between five USDA and five Amalgamated Sugar Company low-damage SBRM selections. The test consisted of single-row plots in a completely randomized design with 1 to 10 replications per entry in accordance with the quantity of seed available for each cross. The results for these crosses are given in Table 4. All of the crosses except one had a rating of less than 2.0. Three crosses, 40I37, 40I42, and 40I56 were very resistant to root maggot damage and will be used to further develop breeding material for the sugarbeet industry.

Table 3. Maggot damage rating in % of parent population 25A2 for five cycles of selection.

Selection	1976	1977	1978	1979	1980
High damage	116	103	121	114	133
Low damage	96	86	89	80	76

Table 4. Performance of single crosses between USDA and Amalgamated Sugar Company low-damage selections, Section III, 1980.

Designation	No. Replications	Vigor June 10	Vigor July 2	Percent Plants With Curly Top	SBRM Mean Damage
40I35	3	2.33bc[1/]	2.0b	0	1.07abc
40I37	1	2.00ab	2.0b	0	.5a
40I38	10	1.70ab	2.0b	1.0	1.21abcd
40I41	7	1.71ab	2.0b	0	1.23abcd
40I42	8	1.88ab	2.0b	1.0	.86ab
40I46-1	5	1.80ab	2.0b	11.0	1.72cde
40I47-2	10	2.00ab	2.0b	6.0	1.62cd
40I47-4	3	2.00ab	1.67a	6.8	1.53bcd
40I49-1	10	1.40a	2.0b	2.1	1.87de
40I49-2	3	2.00ab	2.0b	0	1.07abc
40I50	4	2.00ab	2.0b	0	1.1abcd
40I5	2	1.50ab	2.0b	0	1.45bcd
40I52	4	1.75ab	2.0b	0	1.58bcd
40I53	1	3.00c	2.0b	0	1.3bcd
40I54	3	1.67ab	2.0b	0	1.13abcd
40I56	3	3.00c	2.33c	16.7	.87ab
40I57	2	3.00c	2.0b	0	2.35e
1166	10	2.00ab	2.0b	2.0	1.19abcd
F. Value		2.46**	2.09*		2.46**

Section IV

Fourty-four testcrosses of L53CMS X low-damage selections from population 25A2 were made in the greenhouse at Logan and tested in the field at Kimberly in 1980. In addition, 28 sib and selfed selections were evaluated in an adjacent field plot. The range and mean SBRM damage ratings are summarized in Table 5. The range of the testcrosses was wider than the self and sibbed lines. The testcrosses showed excellent combining ability for low maggot damage.

Table 5. Range and mean SBRM damage ratings for testcross hybrids and inbreds.

Description	No.	SBRM Damage Rating	
		Range	Mean
L53CMS X LD Testcrosses	44	.45 to 2.43	1.45
USDA Sib and Ø Selections	28	.87 to 1.91	1.37

VI. DISEASE STUDIES

DETECTION OF BEET CURLY TOP VIRUS IN VIRULIFEROUS BEET LEAFHOPPERS BY ENZYME-LINKED IMMUNOSORBENT ASSAY

D. L. Mumford

Curly top disease in sugarbeet, tomato, cucurbits, and other crops in California is controlled by identifying large populations of the beet leafhopper vector and reducing their number with insecticide sprays. This method of control would be more effective if those populations of leafhoppers carrying the highest levels of beet curly top virus (BCTV) could be quickly identified and given special attention during the spray period.

Previous attempts to identify viruliferous beet leafhoppers using fluorescent antibody staining were unsuccessful. This was probably because the virus does not multiply in the vector and is present in very low concentrations. Enzyme-linked immunosorbent assay (EIA) has become a major serological tool in assays of plant viruses. It has been used to detect cucumber mosaic virus in aphid vectors.

This paper describes the use of EIA to detect BCTV in viruliferous beet leafhoppers and discusses a program to monitor BCTV in field populations of the leafhopper.

Materials and Methods

Antiserum against BCTV was obtained from rabbit. The EIA method of Clark and Adams (1) was used with only slight modification. The procedures are briefly described here. The globulin fraction of the antiserum was separated by ammonium sulfate precipitation and conjugated to alkaline phosphatase. The test was done in polystyrene plates containing 96 wells. Plates were coated by incubation at 37 C for four hours with globulin diluted in sodium carbonate buffer. After coating, plates were stored at 5 C until used. It was found that sensitivity was increased and the occurrence of occasional erratic readings in some wells was reduced if phosphate-buffered saline containing .05 percent Tween 20, 2 percent polyvinylpyrolidone (MW 40,000) and 1 percent bovine serum albumin (PTPB) was incubated in the plate wells for one hour at 37 C before and after incubation of the test sample.

Extracts for testing were prepared by grinding leafhoppers in .6 ml of PTPB in 2 ml glass tissue grinders. Extracts were introduced directly into the coated wells and incubated overnight at 37 C. Conjugate diluted in PTPB was incubated in plate wells for four hours at 37 C after incubation of the extracts. The substrate p. nitrophenyl phosphate was next incubated in each well for one hour at room temperature. The resulting dephosphorylation reaction was stopped by the addition of 3 M NaOH. The absorbance at 405 mm (A405) was determined for the contents of each well with a spectrophotometer.

Leafhoppers known to be viruliferous were obtained by allowing them to feed on infected sugarbeet plants or through a membrane on clarified extracts from

infected tobacco plants. Extracts of BCTV were brought to 10 percent sucrose to encourage feeding. To evaluate field populations of beet leafhoppers, 30 leafhoppers were collected from each reproduction site in California and sent frozen in dry ice to the laboratory where they were assayed in groups of 10 leafhoppers.

To measure the amount of infection viruliferous leafhoppers would produce, a moderately resistant commercial cultivar, GWD2, was used. Three-week-old seedlings were inoculated by caging a single leafhopper on one cotyledon of each of 40 seedlings for five days. The number of seedlings showing disease symptoms three weeks after inculation was taken as a measure of the level of virus present in the viruliferous leafhoppers.

Results

Initially, assays were run on extracts from groups of 30, 20, or 10 leafhoppers that had fed for 24 hours on either infected plants or clarified extracts from infected plants. In all such tests, groups of viruliferous leafhoppers gave positive EIA readings when compared to groups of nonviruliferous leafhoppers of similar size. These results suggested that field populations of leafhoppers could be monitored for BCTV. More extensive tests were next done to determine whether BCTV could be detected in single leafhoppers, and to see how EIA results compared with infection percentages produced when similar leafhoppers were caged individually on susceptible sugarbeet seedlings. Until now, the only way to evaluate whether leafhoppers were viruliferous was to cage them on seedlings and observe the percentage infection they produced.

The results reported in Table 1 clearly show that BCTV can be detected in single viruliferous leafhoppers by EIA. They also show that results obtained by EIA correlate very well with percentage infection results from caging leafhoppers individually on sugarbeet seedlings. It can be estimated from the results in Table 1 that a leafhopper carrying over 0.5 mg of BCTV will likely produce symptoms on greenhouse grown seedlings of GWD2, if it is permitted to feed on the seedling cotyledon for approximately five days.

During 1979 and 1980, BCTV content was monitored in field populations of leafhoppers from 21 and 38 sites, respectively, in California. Sites selected were those annually treated with insecticides to reduce leafhopper populations. Thirty leafhoppers were tested from each site on 10 different dates each year from January to April. In 1979, leafhoppers from two sites were consistently the highest in virus content. These two sites received additional attention during the insecticide spray period. During both 1979 and 1980, the level of BCTV concentration in leafhoppers sampled was generally very low. This corresponded to very low levels of curly top disease reported in crops during those two years.

Discussion

Curly top disease is noted for its unpredictable sporadic severe outbreaks. This is because so many unpredictable factors influence such outbreaks. An abundance of viruliferous leafhoppers is probably essential for a severe outbreak. This can now be determined rapidly and before the vectors move into

the commercial crops using the procedures described here. By monitoring virus levels in field populations, a disease outbreak may be indicated; however, it may or may not develop because other factors limit vector movement. On the other hand, if the detection of very low levels of virus in reproductive leafhopper populations before planting is correlated with very low disease levels in the subsequent crops, then costly protective measures may be avoided during those years.

Table 1. Comparison of beet curly top virus (BCTV) content in single beet leafhoppers as detected by enzyme-linked immunosorbent assay (EIA) with the percentage infection similar leafhoppers produced when caged singly on sugarbeet seedlings.

Dilutions of a BCTV Preparation Fed to Leafhoppers	Percentage of Single Leafhoppers With Over 0.5 mg Virus	Percentage Infection in Sugarbeet Seedlings Inoculated With Single Leafhoppers
0	0[a]	0[b]
1:324	0	0
1:162	3	5
1:54	17	16
1:18	43	47
1:6	77	83

[a]Results based on EIA of 30 single leafhoppers.

[b]Results based on 40 leafhoppers, each caged individually on a seedling.

Literature Cited

1. Clark, F. M., and Adams, A. N. 1977. Characteristics of the microplate method of enzyme-linked immunosorbent assay for the detection of plant viruses. J. Gen. Virol. 34:475-483.

VII: PHYSIOLOGY - BIOCHEMISTRY

REDUCTION IN SINK MOBILIZING ABILITY FOLLOWING PERIODS OF HIGH CARBON FLUX

Roger Wyse

Introduction

The importance of sinks in regulating photosynthate distribution and photosynthetic rates have been well documented (Loomis et al. 1976). For example, a rapid change in source demand initiated by selective leaf shading or leaf removal brings about a rapid compensatory change in export from the remaining leaves without changing photosynthetic rates in short-term experiments (Geiger, 1976; Borchers et al. 1979). Rapid alterations in sink demand also cause rapid changes in the distribution of assimilates (Fellows et al. 1979). Although rapid changes occur in export and distribution patterns, compensatory changes in photosynthetic rates may take several days (Thorne and Koller, 1974). The changes in photosynthetic rates apparently require changes in the photosynthetic apparatus (Wareing et al. 1968; Thorne and Koller, 1974). However, in other experiments where sinks are removed or stems are girdled, a rapid decrease in photosynthetic rates were observed (Setter, et al. 1979). These changes in photosynthesis were correlated with rapid increases in the ABA content of leaves with a corresponding increase in stomatal resistance.

Ontogenic changes in sink demand may or may not relate to changes in photosynthetic rates. In many cases, increased reproductive sink demand causes remobilization of carbohydrate reserves in stem, petiole and pod tissue (Streeter and Jeffers, 1979; Thorne, 1979). A short-term diurnal accumulation of assimilates in the soybean pod wall may act as a reservoir of starch and sucrose, thus distributing the photosynthate supply to the developing seed uniformly over the diurnal cycle (Thorne, 1979). Such data would suggest that the sink may become limiting in its ability to absorb assimilates when photosynthetic rates are high. This limitation may be through an alteration or reduction in a sucrose gradient between source and sink. This gradient has been hypothesized (Ho, 1976; Milburn, 1974; Walker and Thornley, 1977) to regulate flux between source and sink.

Previous work has suggested that the sugarbeet root sink plays an important role in determining photosynthetic rates (Milford and Pearman, 1975; Habeshaw, 1973). Reductions in mobilizing ability of the sink resulted in increases in carbohydrate concentration in leaves while enhanced sink demand increased net assimilation rates. Because of the importance of sucrose metabolism in the root sink on photosynthate partitioning, we have undertaken a study to determine the capacity of the sugarbeet root sink to absorb sucrose throughout a diurnal cycle and after prolonged alterations in photosynthate supply. Our objective was to determine if the sink may become limited in its ability to absorb assimilates following periods of rapid photosynthesis.

Materials and Methods

An adapted sugarbeet cultivar (Cultivar AH12, Amalgamated Sugar Company, Ogden, UT) was planted on May 20 and maintained in competitive stand until treatments were initiated on September 15. The average root weight at this time was

approximately 1 kg and the sucrose content 16% (F.W.).

To determine the diurnal pattern of sucrose uptake rates by sugarbeet taproot tissue, plants were harvested at approximately 2-h intervals between 0800 and 1800 h. At each sampling time, three roots were harvested and equal number of discs prepared from each root. The discs from all roots were then combined for equilibration.

Photosynthate supplies to the root were manipulated by either altering the duration of photosynthesis by shading or by carbon dioxide enrichment. In Experiment 1, the treatments were limited to total shade (85% reduction in photon flux density), CO_2 enrichment with 1000 ppm CO_2 in the canopy, and an ambient light and CO_2 control. Each treatment consisted of five plants of uniform size. To maintain a 1000 ppm CO_2 atmosphere in the canopy, a polyethylene barrier 1 m high was placed around the plants and compressed CO_2 injected into the canopy. Air within the polyethylene barrier was circulated with two small centrifugal fans. In a second experiment, the preliminary treatments were repeated with the addition of three light duration treatments consisting of 6-, 3- and 1-h light periods prior to a late afternoon (1600 h) sampling. All treatments were initiated at 1000 h on the previous day. All five plants from each treatment were harvested and an equal number of discs prepared from each root. The discs were combined in the equilibration media. The sucrose uptake capacity of tissue from the taproot sink was determined essentially as described previously (Saftner and Wyse, 1980).

The uptake capacity was determined on 1 X 6 mm discs which had been washed for 1 min in tapwater to remove sucrose from the cut cells on the surface. Thirty discs were then placed in 3 ml of 30 mM MOPS (pH 7.0) containing 40 mM ^{14}C-sucrose (50,000 dpm/µmol) with or without 5.0 µM CCCP. The tissue was then incubated for 4 h. After incubation, the tissue was given four 1-min washes prior to extraction in hot 80% ethanol. Active sucrose uptake was calculated as total uptake minus uptake in the presence of CCCP.

In Experiment 1, estimates of sucrose concentrations in the cellular compartments of the taproot were determined. A compartmental flux analysis (Macklon and Higinbotham, 1970) was also used to determine the amount of sucrose in each compartment in a set of unwashed discs. Sucrose in each fraction was determined as total carbohydrate by the anthrone method (Scott and Melvin, 1953). Assuming the volume of the compartment did not change with treatment, the concentration in the compartments would be proportional to the amount of sucrose in each compartment. Estimates of starch levels were made by sampling recently mature leaves from each of the five plants in each treatment. The leaves were freeze dried, ground through a 40-mesh screen with a Wiley Mill and analyzed for starch by the method of Haissig and Dickson (1979).

Results and Discussion

The site and pathway of sucrose unloading from the phloem in the root sink of sugarbeet has not been clearly defined. However, we assume the mobilizing ability of the sink can be estimated from the rate of sucrose uptake by excised tissue discs from dilute sucrose solutions. This system requires transport at both the plasmalemma and tonoplast. In the intact system, only the tonoplast may be involved if phloem unloading is symplastic. We have not found the plasmalemma to be a significant barrier to sucrose uptake in fresh tissue discs.

Rates of sucrose uptake by excised root tissue discs were inversely related to the amount of photosynthate available during the previous light period (Table 1). Control plants exposed to ambient CO_2 in approximately 10 h of photosynthetically active radiation exhibited uptake rates of 230 nmol/h/g. As the light period was shortened from 10 to 0 h, there was progressive increase in rates of uptake in both experiments. When photosynthate supply was enhanced by increasing the CO_2 concentration from ambient to 1000 ppm, sucrose uptake rates by the tissue discs were significantly reduced. These data suggest that the sugarbeet root sink's ability to absorb sucrose is inversely related to the amount of photosynthate from source to sink during the preceding light period. Thus, sink capacity may limit translocation during periods of high photosynthetic activity. If translocation was lagging behind photosynthesis, leaf starch levels would be expected to increase.

Table 1. Sucrose uptake by sugarbeet root tissue slices taken from plants exposed to various durations of PAR or 1000 ppm CO_2 prior to a 1600 h sampling.

Light duration and CO_2 treatment	Expt. 1		Expt. 2	
	Active	Passive	Active	Passive
	$nmol \cdot h^{-1} \cdot g^{-1}$			
10 h C	230	350	360	340
10 h, 1000 µl/l CO_2	180	370	270	330
6 h light			440	310
3 h light			490	350
1 h light			550	390
0 h light	380	410	670	370
LSD (.05)	40	40	60	30

Starch levels in the control plants harvested at 1400 h were 8.1 ± 0.5 per cent on a dry weight basis. Shaded plants were approximately 50 per cent lower (4.2 ± 1.4) while the 1,000 ppm CO_2 enriched plants were 50 per cent higher (12.4 ± 2.3). This inverse correlation between sink uptake and starch accumulation supports the hypothesis that the sink may limit productivity.

When the sucrose uptake capacity of the sugarbeet root tissue was followed from early morning until dusk, there was no significant change in sucrose uptake capacity until late in the afternoon (1800 h) (Table 2). On the days in which these experiments were run, the over-night temperature was approximately 5° C. Photosynthetic rates (data not shown) were extremely low until approximately 1100 h. Therefore, the supply of photosynthate did not reach a maximum until at least noon. Thus the rate of photosynthesis probably did not exceed the capacity of the root sink to absorb sucrose until very late in the afternoon.

According to the hypothesis of Ho, the flux of sucrose between source and sink should be regulated by the sucrose gradient sensed by the phloem--the gradient between the site of loading and the site of unloading. Compartmental analysis of the sucrose content in the vacuole cytoplasm and free space in the first experiment shows that the free space sucrose content

was not affected by the shading of CO_2 enriched treatments (Table 3). However, the cytoplasmic compartment of the CO_2 enriched plants was four times higher than that in the control or shaded treatments. This build up of CO_2 in the cytoplasm would suggest that a barrier existed in the active transport of sucrose from the cytoplasm to the vacuole when photosynthetic flux to the root was high. This higher cytoplasmic sucrose content may reduce phloem unloading, thus decreasing flux from the leaf. The decreased rate of export from the source leaf would result in higher levels of sucrose in the leaf free space. This higher sucrose level would result in greater starch accumulation through its effect on sucrose synthesis, triose phosphate transport and cytoplasmic phosphate levels (Geiger, 1979).

Table 2. Sucrose uptake capacity of sugarbeet root tissue throughout diurnal light period.

Time of Day	Sucrose Uptake	
	Active	Passive
	$nmol \cdot h^{-1} g.^{-1}$	
0800	730	480
1030	743	437
1300	722	436
1530	749	463
1800	614	481
LSD (.05)	100	60

Table 3. Sucrose content of free space, cytoplasm and vacuole in the taproot of control, shaded or CO_2-enriched sugarbeet plants.

Treatment		Compartment		
		Vacuole	Cytoplasm	Free Space
		mg sucrose/g		
Control	V[1/]	306	6.7	18.8
	P	254	5.9	21.1
		281	6.4	19.9
Shaded	V	308	8.1	16.7
	P	259	6.0	18.0
		284	7.1	17.3
CO_2 Enriched	V	291	26.3	17.1
	P	237	23.7	20.9

[1/] V - vascular tissue; p - interzone parenchyma

These data suggest that in some cases the ability of the sink to absorb sucrose may be limiting photosynthetic rates at certain stages of growth or times within the diurnal cycle. These data would further suggest that the secondary sinks which exist in many plant tissues, i.e., soybean (Thorne, 1979) may be a mechanism by the plant to increase its total sink capacity and thus regulate the flow of carbon to the developing sink at a more uniform rate throughout the diurnal cycle.

Recently Saftner and Wyse (1980) described the mechanism for sucrose transport into the vacuole of the sugarbeet taproot sink. The model suggests that the gradient of potassium from the outside to the inside of the vacuole and the reverse gradient of protons drives the uptake of sucrose. This gradient would depend on an active ATPase on the tonoplast which would generate the proton/potassium gradients required. During periods of rapid assimilate transport to the sink, this proton/potassium gradient may be degraded. When this occurs, the rate of sucrose uptake would decrease. Thus, the ATPase activity at the tonoplast may be the factor limiting sucrose uptake in sink tissue such as the sugarbeet taproot.

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SUCROSE CONTENT IS NOT REGULATED SOLELY BY RING DENSITY AND CELL SIZE

Roger Wyse

Introduction

The partitioning of dry matter in the taproot of sugarbeet is regulated in the root sink (Wyse, 1979) and is independent of photosynthate supply (Wyse, 1980). However, the mechanism controlling partitioning within the taproot sink of sugarbeet is not well understood. It has been hypothesized that cell size and ring density control or influence partitioning between sucrose and non-sucrose dry matter (Wyse, 1979; Doney et al. 1981). This control mechanism appears to be operating when one compares sugar and fodder types. To further test the cell size and ring density hypothesis, a sugarbeet (AH-11) and fodder beet (Blanca) were grown in spacings from 25 to 400,000 plants per hectare. Our objective was to determine if a fodder type could be converted to a sugar type at very narrow spacings where cell size would be decreased and ring density increased. The results suggest that some unknown factor in addition to cell size and ring density also influences sucrose content in *Beta vulgaris*.

Materials and Methods

AH-11 and Blanca were planted in a replicated field trial on May 20, 1980. Each genotype was planted at five equidistant spacings of 5, 9, 12, 18 and 24 inches. These equidistant spacings represented populations of approximately 25, 50, 100, 200 and 400,000 plants/ha. The normal spacing in the intermountain area results in a population of approximately 60,000 plants/ha. The plants were fertilized with 225 kg nitrogen/ha. This high level of nitrogen was used so that a nitrogen deficiency factor would not be superimposed on the population treatments.

The plots were harvested on October 15. Analyses were made for total dry weight of tops and roots. Each plot was further subsampled for determinations of ring number and cell size. Vascular and parenchymal tissue were sampled with a 3 mm cork bore. The cores were then divided into three subsamples--one frozen and juice expressed for RDS and osmotic concentration measurements. A second sample of vascular and parenchymal tissue was extracted with an 80% ethanol and analyzed for sucrose, amino acids and reducing sugars. A third subsample was ashed, the per cent ash on dry weight calculated and the sodium and potassium content of the ash determined. Sucrose on whole roots was estimated by standard polarigraphic methods. Sucrose content in the ethanol extract was measured as reducing sugars after invertase hydrolysis with dinitrosalicylic acid. In the ethanol extract, reducing sugars were determined using the method of Nelson (1944) and amino acids using ninhydrin (Rosen, 1957). Sodium and potassium were measured in the ash samples by flame photometry.

Results and Discussion

The per cent sucrose on fresh weight increased with population in the range of 25 to 100,000 population in both genotypes (Figure 1). The fodder beet remained constant between 100 and 400,000 while the sugar type showed a decline at the higher populations. On a dry weight basis, sucrose content in AH-11 was a maximum at 100,000 population, while in the fodder beet, a

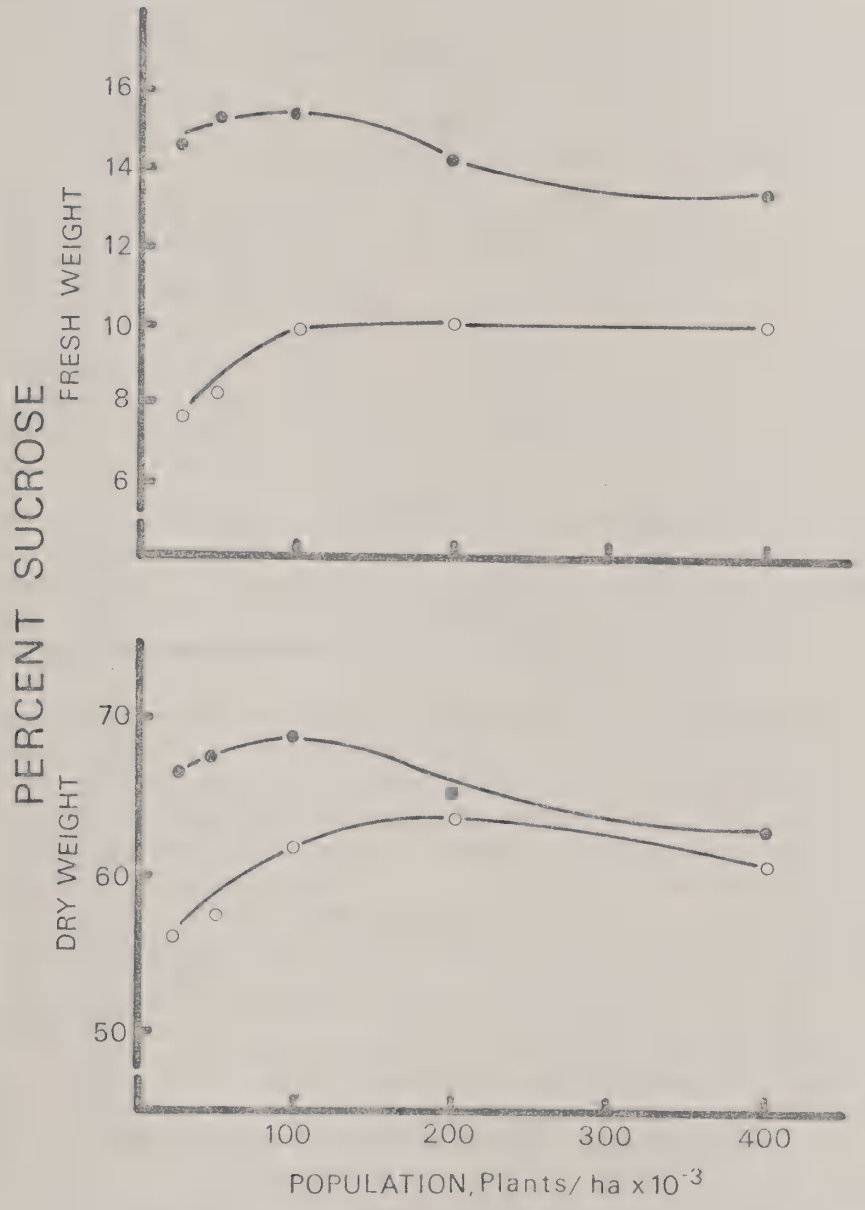

Figure 1. Sucrose content on both a fresh and dry weight basis for Blanca (○) and AH-11 (●) grown at five populations.

maximum was attained at 200,000 plants/ha population. Both genotypes declined in sucrose as the population was increased to 400,000 plants/ha.

Total dry matter production was higher for the fodder beet than for the sugar type at all populations (Table 1). However, both genotypes continued to increase in total dry matter production with increases in population. Sucrose production per hectare was maximized at 50,000 population for the sugar type and approximately 100,000 for the fodder beet.

Table 1. Total dry matter and sucrose yield in a fodder beet and sugarbeet genotype grown at five plant densities.

	Total Dry Matter		Sucrose		Per Cent Root	
Population/ha	AH-11	Blanca	AH-11	Blanca	AH-11	Blanca
	T/ha		Kg/ha			
25,000	16.7	17.4	8303	7883	69.0	75.5
50,000	20.6	24.3	9680	11293	65.9	74.5
100,000	17.7	20.5	7313	9194	57.5	67.9
200,000	18.8	23.3	6037	10527	51.6	64.5
400,000	20.2	26.6	5664	10281	41.5	58.8

Due to the stand density changes, there was a marked alteration in the partitioning pattern between root and shoot. At the higher populations, there was a greater proportion of petiole and leaf than at the lower population (Table 1). This is a typical shading response. The fodder type partitioned a greater proportion of the total biomass to root at all populations.

Cell volume measurements were made in the interzone parenchymal region near the mid point between the center and outside of the root. The mean cell size for the sugar type at 25,000 plants/ha was approximately equal to the mean cell size of the fodder beet at 200,000 and 400,000 plants/ha (Figure 2). Thus if cell size were a controlling factor, one would expect the sucrose content to be similar in the two genotypes when cell sizes were similar. However, at 25,000, the sugar type had an average sucrose content of 14.6 while the fodder beet at 400,000 had a sucrose content of only 10%.

Differences were also apparent in the distribution of dry matter and soluble dry matter components in the root of fodder beet and sugarbeet (Table 2). There was very little difference between the sucrose content (dry weight basis) between vascular and parenchymal tissue of the sugar type grown at any of the stand densities. However, Blanca showed wide differences in sucrose (dry weight) between vascular and parenchymal tissue at the lower spacings when the ring widths were widest. In both genotypes, the osmotic concentration in vascular and parenchymal tissue at each of the spacings was not different. This suggests that an osmotic adjustment had occurred in the parenchymal tissue, particularly in the fodder type. This osmotic adjustment is evident in the higher concentrations of amino acids, reducing sugars and potassium in parenchymal tissue. In all cases the fodder beet parenchymal cells were much higher in these three components suggesting that the osmotic difference due to sucrose content between vascular and parenchymal tissue had been adjusted by these three compounds. This same osmotic adjustment occurred only in Blanca when cell size and density were the same as AH-11.

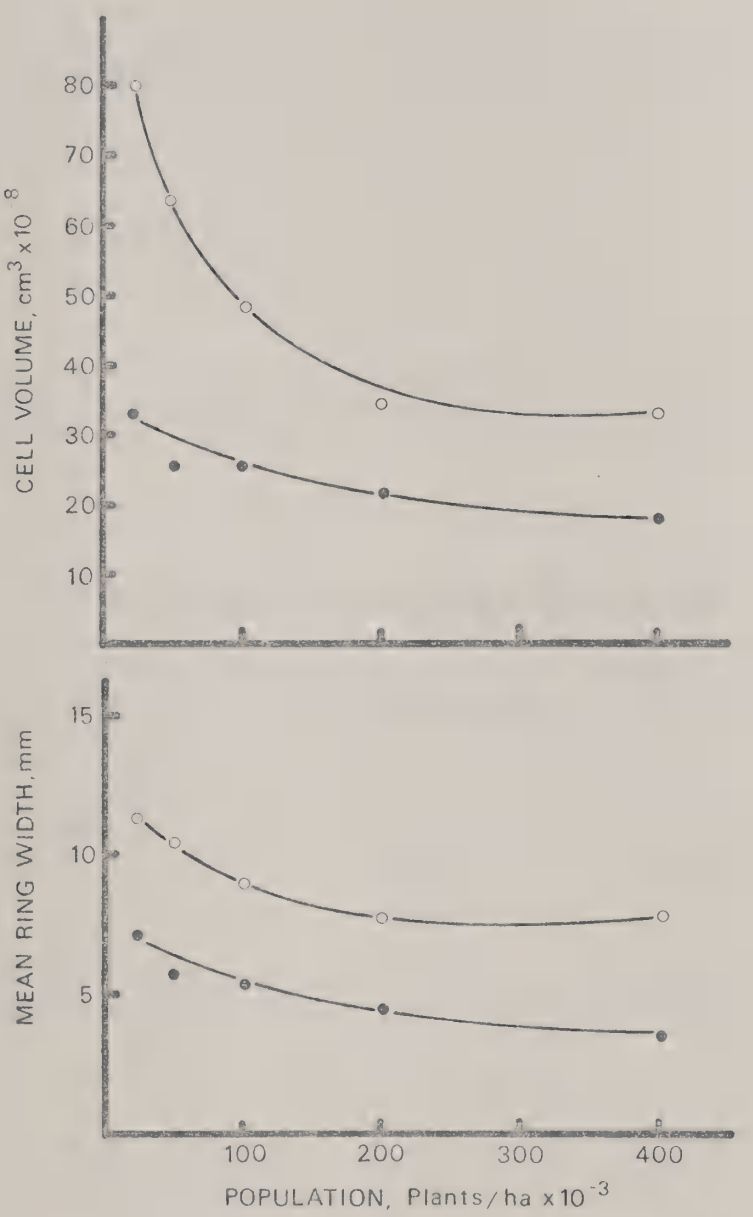

Figure 2. Cell volume and mean ring width for Blanca (○) and AH-11 (●) grown at five populations.

Table 2. Distribution of dry matter and dry matter components in the roots of a fodder beet and sugar-beet genotype grown at five plant densities.

Population/ha		Sucrose	Osmotic Conc.	RDS	Ash	Dry Matter	Amino Acids	Reducing Sugars	Potassium	Sodium
		% DW	Osmoles	% w/w	% DW	%	mg/g dw			
AH-11										
400,000	V[1/]	73.9	809	19.9	1.51	22.4	13.4	3.5	311	49
	P	71.5	863	20.3	1.43	22.2	11.9	2.7	328	43
200,000	V	74.0	852	19.8	1.80	22.2	13.5	3.8	356	42
	P	74.5	823	19.3	2.24	21.6	13.7	3.5	883	57
100,000	V	69.4	822	19.7	1.69	22.5	10.6	3.5	246	33
	P	75.7	801	19.5	2.12	21.4	10.2	2.7	374	55
50,000	V	70.2	826	19.5	1.83	22.4	12.2	3.7	444	46
	P	68.1	846	19.4	3.03	20.9	16.6	4.0	481	66
25,000	V	68.3	751	17.9	3.34	20.3	15.9	3.8	468	46
	P	69.9	755	16.4	5.90	18.3	21.8	4.7	531	54
Blanca										
400,000	V	64.6	588	13.8	3.40	16.0	31.0	5.3	505	193
	P	56.6	618	12.1	7.74	13.8	38.8	27.5	720	135
200,000	V	71.6	598	14.2	2.82	16.5	19.6	4.8	488	226
	P	72.1	630	11.2	9.52	13.1	41.4	53.4	718	109
100,000	V	74.1	589	13.6	3.24	15.9	19.4	4.8	546	200
	P	61.4	586	10.0	9.15	11.4	46.2	48.4	848	153
50,000	V	62.9	566	13.0	3.39	15.1	15.2	6.1	541	265
	P	38.0	549	8.3	13.00	10.2	67.5	111.7	1025	108
25,000	V	58.5	541	12.1	3.47	14.6	16.1	6.5	655	269
	P	35.7	512	7.8	12.42	9.8	59.1	84.3	1006.	119

1/ V - vascular tissue; P - interzone parenchyma

In other words, even when cell size and vascular densities are similar, the fodder beet still has higher amino acids, reducing sugars and potassium in the interstitial parenchymal cells suggesting a basic physiological difference between the two genotypes.

From this study, we conclude that the differences in assimilate partitioning between sucrose and non-sucrose dry matter in the root sink of fodder beet and sugarbeet are controlled in part by cell size and vascular density. However, other physiological controls exist which also provide a strong influence on carbon allocation patterns. Therefore, further work is needed to develop a thorough understanding of carbon allocation in the root sink of *Beta Vulgaris*.

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VIII. FODDER BEET AND SUGARBEET FOR BIOMASS FUEL

J. C. Theurer and D. L. Doney

Widespread interest has been generated during the past few years regarding the potential use of fodder beets for alcohol fuel production because root yields are higher than for sugarbeet. European data show fresh root yields of 60 to 160 metric tons per hectare with a dry matter content from 8 to 19 percent for the currently used fodder beet varieties. New Zealand studies (Dunn etal. 1978[1/]) also suggested that greater yields of fermentable sugars are possible from fodder beet than from sugarbeet. Very little attention, however, has been given to the use of sugarbeet or fodder beet as a "fuel crop" in Europe.

The fodder beet has not been grown extensively in the United States as a field crop. However, in most ways this crop would be cultured very similarly to current methods for producing a sugarbeet crop since fodder beets are of the same species and are somewhat similar in growth. Critical research data from actual field testing to compare sugarbeet and fodder beet varieties, and to assess their relative merit as "fuel crops", is urgently needed.

A. NATIONAL COOPERATIVE FODDER BEET TRIAL

In a special alcohol fuel research meeting, held at Salt Lake City, Utah, on February 5, 1980, a proposal was made and plans established to conduct a uniform cooperative fodder beet field experiment at seven locations during the summer of 1980. Dr. J. Clair Theurer served as the project supervisor. The locations and cooperating scientists at each location is given below.

Location	Cooperator
Logan, Utah	Dr. Devon Doney, Research Geneticist
American Falls, Idaho	Dr. John Gallian, University of Idaho Extension Agronomist
Fort Collins, Colo.	Dr. Garry Smith, Research Geneticist
Salinas, Calif.	Dr. Robert Lewellen, Research Geneticist
East Lansing, Mich.	Dr. George Hogaboam, Research Agronomist
Fargo, N. Dak.	Dr. William Bugbee, Research Pathologist
Meridian, Miss.	Dr. Dempsey Broadhead, Research Agronomist

All of the locations except American Falls and Meridian were major USDA-SEA-AR sugarbeet research stations where personnel were very familiar with sugarbeet cultural practices, sampling techniques, harvest procedures, and laboratory analysis of sugars. Field harvest and laboratory analysis for the American Falls test was completed in cooperation with John Gallian (U of I) and under the direction of Logan personnel. The Meridian test was abandoned because leaf spot and root rot diseases destroyed almost all plants in the test, and those beets that survived to harvest were badly deformed.

1/ Dunn, J. S., Henderson, C. F., Pointer, D. J., Steele, P. E., and Young, R. J. 1978. Ethanol produced from fodder beet. New Zealand Agricultural Engineering Institute, Lincoln College, Canterbury, New Zealand.

Materials and Methods

Experimental Design

The experiment was planned to be of a similar design at all locations with each location following the recommended cultural practices for sugarbeets in their locality. Individual plots in each experiment were 4 rows, 6 meters (20± feet long), and of a standard row width of 56 cm or 71 cm (22 or 28 inches), used for sugarbeets at each of the specific locations. At the 4- to 6-leaf stage, plots were thinned to leave one plant every 20 to 30 cm (8 to 12 inches) within the row. Planting dates and harvest dates were as follows:

	Logan	American Falls	Fort Collins	Salinas	East Lansing	Fargo
Planting Date	May 2	Apr. 22	Apr. 18	Apr. 9	May 5	May 20
Harvest Date	Oct. 15	Oct. 8	Oct. 6	Oct. 7	Oct. 15	Sept. 29

Cultural Practices

Fertilizer and irrigation were the standard practices for growing sugarbeets at each locality. No fertilizer was applied at the Fargo location due to a high residual nitrogen level in the soil. At some locations, herbicides were used for weed control. At Salinas, sulphur was applied to control powdery mildew. Thimet was incorporated into the soil at American Falls, and a weekly spray program with malathion was followed at Logan to control curly top. Benlate and Super Tin 4L were used to control leaf spot at East Lansing. Fort Collins had a serious infestation of grasshoppers in July and August and cygon was applied by helicopter for control.

Varieties

Sixteen entries were included in the experiment consisting of 14 of the best current commercial fodder beet varieties from Europe, and two commercial hybrid sugarbeet varieties as checks (Table 1). Great Western Mono-Hy-D2 was used as a uniform check and was planted at all locations. The other sugarbeet check variety was a high yielding, locally adapted variety, selected by each cooperator.

At the Fort Collins location, GWD2 served as the local check as well as the standard uniform check. A high yield variety from the Netherlands, Zwaan Poly, was included in the test in place of another local check variety. The locally adapted check varieties for the respective locations were: USH11 at Salinas; AH10 at Logan and American Falls; GWD2 at Fort Collins; Hilleshog 309 at Fargo; and USH20 at East Lansing. Personnel at the Logan station packaged the seed of each entry except the local check variety and shipped the seed to each location on March 5, 1980. Each station packaged the seed of their local variety and planted the experiment.

Table 1. Root, top, sugar, and potential alcohol yield of European fodder beets in uniform cooperative field experiment, Logan, Utah, 1980.

Variety	Root Weight	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield, Gal/A 1/
GWD2	[illegible]	53.62	17.38	0.20	11.22	715
AH10	5[illegible]	54.65	16.70	0.20	9.14	583
Lamono I	92.[illegible]2	40.31	12.30	0.33	11.75	748
Lamono II	100.[illegible]4	38.99	12.17	0.49	12.65	806
Monorosa	76.20	55.49	13.98	0.28	10.82	689
Yellow Daeno	88.18	42.09	10.20	0.55	9.51	606
Monoblanc	80.69	54.81	12.54	0.34	10.36	660
Kyros	94.30	47.36	11.64	0.37	11.31	721
Monara	101.20	45.09	9.14	0.50	9.77	623
Monriac	94.68	51.99	12.05	0.31	11.77	750
Eckdobarres	98.30	46.84	9.43	0.51	9.78	623
Oscar	102.41	44.80	9.43	0.63	10.30	656
Beta Rose Sugar	81.80	55.78	11.23	0.40	9.50	605
Barsein	88.13	48.19	13.24	0.37	11.99	764
Monovigor	95.77	53.11	12.08	0.29	11.80	752
Monosrover	95.70	42.66	11.44	0.32	11.27	718
Mean	88.03	48.49	12.18	0.38	10.81	689
LSD .05	8.31	7.26	0.89	0.08	1.22	78
C.V.	11.61	18.42	8.95	24.97	13.92	13.92

1/ To convert to liter/hectare, multiply by 9.35.

Variety trials at all locations were harvested by hand. All beets from 18 feet of the two center rows of each plot were dug, cleaned, and separated into roots and tops by removing all green from the crowns and leaving the crowns intact with the root. Roots and tops were immediately weighed to determine root and top weight of each variety. Two representative tops were weighed, dried in an oven at 100 C, and reweighed to determine dry matter percent in the tops. Ten or more beets from each plot row were washed and sampled using standard sugar-beet laboratory techniques for sugar analysis. A sample of pulp was weighed, dried in an oven at 100 C, and reweighed to determine the dry matter of the root for each variety. Percent sucrose was determined by the standard cold digestion method for the Logan, Salinas, and American Falls locations, and by the thin juice method at Fort Collins, Fargo, and East Lansing. Brei samples were clarified with aluminum sulfate solution (1 gm anhydrous aluminum chloride/liter of water) instead of the normal subacetate solution.

Five to ten ml of filtrate from each field plot at each location was frozen and shipped to Logan for use in determining sugars other than sucrose in the beet varieties. Reducing sugars (glucose and fructose) were quantified in the filtrate using dinitrosalicylic acid reagent and determined for sugar content

colorimetrically. Sodium and potassium content of the varieties grown at Logan and American Falls were determined on the filtrate with a Corning spectrophotometer. A sample of 100+ grams of brei from each plot at each location except American Falls was frozen and sent to the Peoria Research Center for ash, protein, fiber, and total carbohydrate analysis.

Data Summary and Statistical Analysis

Raw data at each location was entered on a series of data sheets and returned to Logan for statistical analysis and summarization of the research project. Statistical analysis was completed using the Utah State University Computer Service.

Results

Logan, Utah Experiment

The trial at Logan had an excellent stand and beets showed good, vigorous growth throughout the growing season. Root yield of the fodder beets ranged from 76.20 to 102.41 metric tons per hectare (34 to 46 t/ha) (Table 1). All varieties were significantly superior in root weight when compared to the GWD2 check. Lamono II, Monara, Eckdobarres, Oscar, Monovigor, and Monosrover had 50 percent greater yield than GWD2. The fodder beet varieties differed in top yield but there was no significant difference between any fodder beet variety and the uniform sugarbeet check. The sucrose percentage of GWD2 (17.38 percent) was significantly better than any of the fodder beet entries, which ranged from 9.14 to 13.98 percent. The best fodder beet variety had only 80 percent as high sucrose content as the check. In general, varieties having high yield were low in sucrose and vice versa. Reducing sugar percentages were all less than 1 percent and averaged 0.38 percent. Fodder beets were higher in reducing sugar than sugarbeets, and those with the highest percentages were also those with the lowest sucrose percentages. Lamono II, a sugarbeet X fodder beet hybrid, had the highest total sugar yield and exceeded the GWD2 check by approximately 13 percent. This was the only fodder beet variety that significantly exceeded GWD2 for total sugar.

Potential alcohol yield ranged from 583 to 806 gallons per acre based on an 85 percent conversion rate (14.0 pounds of sugar equal to a gallon of alcohol).

Dry matter of the fodder beet varieties averaged 17.5 percent in the fresh root and 12.6 percent in the fresh top. All varieties were significantly lower in percentage dry matter than the sugarbeet GWD2 check. Varieties higher in total root dry matter were also those having the highest total sugar yield.

The local check variety, AH10, included in this experiment, is used widely in this area as a commercial hybrid. AH10 was lower in yield, sucrose, and total sugar than GWD2.

American Falls, Idaho Experiment

The plots at American Falls had a few stand problems and showed slight damage due to Nortron herbicide application in the early stage of development. The test results were similar to those observed at Logan (Table 2). The fodder beets had significantly higher root yields than sugarbeets, ranging from 84.58 to 115.84 metric tons per hectare (38 to 52 t/a).

Table 2. Root, top, sugar, and potential alcohol yield of European fodder beets in uniform cooperative field experiment, American Falls, Idaho, 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A 1/
GWD2	64.74	51.52	16.93	0.18	10.97	699
AH10	64.25	48.31	17.63	0.18	11.42	728
Lamono I	102.17	40.31	11.83	0.22	12.32	785
Lamono II	98.84	34.96	11.88	0.26	12.03	766
Monorosa	84.58	51.13	14.54	0.20	12.40	790
Yellow Daeno	94.55	36.67	10.83	0.24	10.48	668
Monoblanc	87.81	43.66	13.05	0.23	11.53	735
Kyros	104.73	36.97	11.27	0.30	11.96	762
Monara	104.22	37.89	9.12	0.31	9.77	622
Monriac	109.68	47.96	10.83	0.21	12.03	766
Eckdobarres	115.84	40.25	7.93	0.32	9.54	608
Oscar	111.37	39.39	10.27	0.43	11.91	759
Beta Rose Sugar	100.78	51.83	9.43	0.28	9.63	614
Barsein	93.31	36.68	13.05	0.25	12.44	793
Monovigor	101.63	42.64	11.84	0.18	12.22	779
Monosrover	95.35	33.73	11.41	0.20	11.01	702
Mean	95.87	42.37	11.99	0.25	11.36	724
LSD .05	16.76	10.08	1.21	0.07	1.92	122
C.V.	21.49	29.25	12.41	35.78	20.81	20.81

1/ To convert to liters/hectare, multiply by 9.35.

The check varieties significantly exceeded the sucrose percentages of the fodder beets. High yielding fodder beet varieties generally were lowest in sucrose percentage and vice versa. The fodder beet varieties were slightly higher in reducing sugar than the sugarbeet checks but none of them exceeded one-half of 1 percent. Fodder beet varieties Monorosa and Barsein significantly exceeded the sugarbeet checks in total sugar yield. Potential alcohol production ranged from 608 to 793 gallons per acre. The local check variety, USH10, was similar in root and top yield to the GWD2 check.

Fort Collins, Colo. Experiment

The Fort Collins field plot had relatively good stand and excellent growth in the early part of the season. A serious infestation of grasshoppers invaded the plot in late July and it became necessary to spray the field to control this insect. A leaf burn and necrosis of the older beet leaves resulted from the aerial insecticide application, possibly due to residual chemical in the spray tanks of the commercial applicator. Growth was set back for a week or two until new leaves developed.

All fodder beet varieties significantly exceeded the GWD2 check for root yield, ranging from 70.10 to 88.74 metric tons per hectare (31 to 40 T/A) (Table 3). The highest yielding variety, Kyros, had 56 percent greater root yield than GWD2. GWD2 was significantly higher in sucrose percentage than all other entries in the experiment. Fodder beets ranged from 9.03 to 12.99 percent sucrose. Fodder beets had far more reducing sugars than sugarbeets; however, only one variety exceeded one-half of 1 percent. The sugarbeet varieties produced the greatest total sugar yield, and consequently they would yield the greatest quantity of alcohol. Potential alcohol yields ranged from 458 to 677 gallons/acre.

Table 3. Root, top, sugar, and potential alcohol yield of European fodder beets in uniform cooperative field experiment, Fort Collins, Colo., 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A 1/
GWD2	56.88	40.70	17.59	0.14	10.06	641
Zwaan Poly	66.81	40.82	15.91	0.10	10.62	677
Lamono I	72.08	25.75	12.54	0.19	9.13	582
Lamono II	75.46	25.78	11.40	0.53	8.93	569
Monorosa	72.84	40.00	12.99	0.23	9.56	609
Yellow Daeno	71.74	29.50	10.05	0.44	7.49	477
Monoblanc	76.44	40.82	11.95	0.26	9.32	594
Kyros	88.74	38.78	11.13	0.30	10.12	645
Monara	82.07	27.11	9.03	0.39	7.69	490
Monriac	77.63	33.44	11.66	0.24	9.12	581
Eckdobarres	78.64	25.61	8.79	0.40	7.19	458
Oscar	86.92	34.40	9.62	0.44	8.67	552
Beta Rose Sugar	83.74	47.45	10.85	0.28	9.29	592
Barsein	70.10	32.06	12.64	0.30	9.06	577
Monovigor	85.66	36.30	11.34	0.24	9.82	626
Monosrover	79.42	32.74	11.78	0.25	9.57	610
Mean	76.57	34.45	11.83	0.30	9.10	580
LSD .05	10.86	9.30	0.87	0.13	1.06	68
C.V.	17.44	33.20	9.07	54.77	14.35	14.35

1/ To convert to liters/hectare, multiply by 9.35.

Salinas, Calif. Experiment

In spite of some damping off of seedlings in the Salinas experiment, a relatively good stand was attained. A low-to-moderate incidence of several diseases occurred in the plot; however, they were not of any magnitude that would influence the validity of the data. The plots appeared to be short on nitrogen and were fertilized mid-season to increase growth. The yield of the sugarbeet varieties was lower than expected for these varieties, which usually produced 90 t/ha (40 T/A) with a 15 percent sugar percentage under similar growth conditions.

Fodder beets again significantly produced greater root weight and had significantly lower sucrose percentage than the sugarbeet checks (Table 4). Monorosa was the fodder beet variety having the highest sucrose percentage, and it was only 76 percent of GWD2. On the average, the reducing sugar was greater for the fodder beets; however, the variety with the largest percentage, Oscar, was only one-third of 1 percent. Barsein produced 12 percent more total sugar than GWD2, a statistically significant difference. Potential alcohol yield ranged from 476 to 689 gallons per acre.

Table 4. Root, top, sugar, and potential alcohol yield of European fodder beets in uniform cooperative field experiment, Salinas, Calif., 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A 1/
GWD2	58.54	25.68	16.17	0.18	9.47	610
USH11	61.33	27.96	15.32	0.16	9.49	604
Lamono I	85.75	18.93	11.28	0.22	9.81	625
Lamono II	81.93	20.21	11.40	0.33	9.65	615
Monorosa	75.05	25.10	12.28	0.18	9.35	596
Yellow Daeno	82.49	21.04	8.92	0.26	7.55	481
Monoblanc	65.14	27.01	11.22	0.23	7.46	476
Kyros	88.14	28.95	10.52	0.26	9.46	603
Monara	100.95	21.25	8.73	0.26	9.06	577
Monriac	84.40	27.56	11.17	0.18	9.53	607
Eckdobarres	100.79	21.50	8.05	0.28	8.37	533
Oscar	92.97	21.42	8.32	0.34	8.06	513
Beta Rose Sugar	96.56	31.85	9.53	0.25	9.44	601
Barsein	85.42	27.92	12.48	0.19	10.81	689
Monovigor	81.92	25.18	11.47	0.23	9.55	608
Monosrover	81.90	20.59	10.52	0.20	8.78	559
Mean	82.70	24.51	11.09	0.24	9.12	581
LSD .05	9.14	4.58	0.78	0.07	1.03	66
C.V.	13.59	22.96	8.60	34.86	13.92	13.92

1/ To convert to liters/hectare, multiply by 9.35.

The adapted check variety, USH11, had higher root yield, slightly lower sucrose percentage, and the same total sugar yield as GWD2.

East Lansing, Mich. Experiment

Fodder beets had higher root weight than the two sugarbeet check varieties with a range of 58.85 to 79.35 metric tons per hectare (26 to 35 T/A) (Table 5). The sugarbeet varieties had significantly greater top weight and sucrose percentage. The highest sucrose percentage of the fodder beets was again the variety Monorosa with 78 percent as much as GWD2. Reducing sugars were significantly higher for fodder beets than for sugarbeets, but again were less than 1 percent. The fodder beet Kyros gave the greatest total sugar yield, which was 7 percent, but not significantly better than the GWD2 check. Potential alcohol varied from 386 to 544 gallons per acre. USH20 yielded about 90 percent as much total sugar as GWD2.

Table 5. Root, top, sugar, and potential alcohol yield of European fodder beets in uniform cooperative field experiments, East Lansing, Mich., 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A 1/
GWD2	52.31	27.23	15.14	0.19	8.02	511
USH20	47.41	28.74	14.90	0.17	7.16	456
Lamono I	67.36	20.05	11.27	0.23	7.74	493
Lamono II	68.14	17.26	11.21	0.40	7.91	504
Monorosa	62.14	17.61	11.78	0.27	7.48	477
Yellow Daeno	65.75	15.40	9.26	0.37	6.32	403
Monoblanc	68.72	23.66	10.96	0.26	7.62	486
Kyros	78.75	22.28	10.62	0.26	8.55	544
Monara	79.35	18.11	8.54	0.39	7.09	452
Monriac	72.19	24.37	10.54	0.24	7.76	494
Eckdobarres	70.93	16.80	8.05	0.45	6.06	386
Oscar	75.30	15.86	8.39	0.50	6.69	426
Beta Rose Sugar	68.49	29.64	9.50	0.27	6.69	425
Barsein	58.85	19.61	10.99	0.35	6.62	422
Monovigor	69.75	20.21	10.84	0.21	7.71	491
Monosrover	65.06	18.85	10.72	0.22	7.11	453
Mean	66.92	20.98	10.80	0.30	7.28	464
LSD .05	8.85	4.48	0.76	0.10	0.97	62
C.V.	16.26	26.23	8.69	42.16	16.40	16.40

1/ To convert to liters/hectare, multiply by 9.35

Fargo, N. Dak. Experiment

A severe early spring drought was experienced at Fargo. One irrigation was required in this normally non-irrigated sugarbeet area. Emerging with the beets was a very heavy population of grass, mallow, and redroot pigweed. A post-emergence herbicide was applied, which, coupled with difficult thinning conditions, resulted in relatively poor stands. The fodder beets at this location also had higher root weight and lower sucrose content than the check varieties (Table 6). GWD2 had more top weight than the fodder beet varieties, but the local check Hilleshog 309 was about equal in top weight.

Sucrose percentage at this location was extremely low. This, no doubt, was due to the high nitrogen residual of 330 N per acre in the plot. The check varieties were higher than fodder beets, but the best one contained less than 11 percent sucrose. Fodder beets were generally higher than sugarbeets for reducing sugar percentage, but as seen previously for other locations, the percentage was only about one-half of 1 percent, or less. Sugar yields averaged only 4.4 metric tons per hectare and GWD2 was equal to the best fodder beet entries. The local check, Hilleshog 309, was significantly better than all fodder beets in total sugar yield and exceeded the best fodder beet variety by 10 percent. The potential alcohol yield was low at Fargo compared with other locations and ranged from 215 to 364 gallons per acre.

Table 6. Root, top, sugar, and potential alcohol yield of European fodder beets in uniform cooperative field experiments, Fargo, N. Dak., 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A 1/
GWD2	43.32	67.80	10.40	0.25	4.65	296
Hilleshog 309	51.91	43.76	10.73	0.25	5.72	364
Lamono I	72.86	47.68	6.73	0.29	5.15	328
Lamono II	65.40	35.53	6.62	0.37	4.55	290
Monorosa	60.89	55.47	7.28	0.27	4.57	291
Yellow Daeno	57.48	40.51	6.63	0.26	3.98	254
Monoblanc	59.57	46.57	6.33	0.36	3.97	253
Kyros	57.69	43.32	6.59	0.40	4.01	256
Monara	70.33	46.80	4.35	0.40	3.37	215
Monriac	67.96	52.79	6.52	0.22	4.54	289
Eckdobarres	70.46	49.33	5.14	0.37	3.87	247
Oscar	80.83	51.68	5.05	0.56	4.46	284
Beta Rose Sugar	78.15	64.14	4.84	0.36	4.03	257
Barsein	56.99	51.34	7.41	0.29	4.38	279
Monovigor	67.70	51.47	6.68	0.25	4.69	299
Monosrover	71.67	53.51	5.93	0.26	4.45	284
Mean	64.58	50.11	6.70	0.32	4.40	280
LSD .05	13.89	10.56	1.11	0.11	1.24	79
C.V.	26.46	25.90	20.27	41.93	34.76	35.78

1/ To convert to liters/hectare, multiply by 9.35.

Combined Locations

There were significant differences between locations with most of the variation due to the Fargo location. Logan and American Falls locations had the greatest sugar yield. Salinas and Fort Collins were intermediate, and East Lansing and Fargo were relatively low in the total sugar produced for fermentation. Significance was also noted for genotypes by locations interactions. At each location, there was a different variety that yielded the highest amount of fermentable sugar (Table 7). At Logan, Lamono II was highest in sugar yield; at American Falls, Monorosa; at Fort Collins, Kyros; at Salinas, Barsein; at East Lansing, Kyros; and Fargo, Lamono I. Only five instances were noted where a fodder beet hybrid significantly produced greater total sugar than GWD2. Fargo was the only location where the local check variety was significantly higher in sugar production than the GWD2 check. The variety Hilleshog 309 was also the only one that exceeded all of the fodder beet entries in sucrose yield.

Table 7. Total sugar yield of fodder beet X sugarbeet hybrids expressed in % of GWD2.

Variety	Logan	American Falls	Fort Collins	Salinas	East Lansing	Fargo
Lamono I	105	111		102		111*
Lamono II	113*	108		101		
Monorosa		113*				
Kyros	101	107	101			
Monoblanc		104				
Monriac	104	109				
Barsein	107	112*		113*		
Monovigor	105	111				101

*Significant at the .05 level.

Discussion

The large visual size of fodder beets gives the impression that fodder beets are the panacea for fuel production and are far superior to sugarbeets as a fuel crop. However, data from replicated field trials at several locations in 1980 indicates that most European fodder beet varieties are not superior to adapted sugarbeet varieties. In addition, all fodder beet varieties are highly susceptible to curly top, cercospora, leaf spot, sclerotium rot, and other serious diseases.

We had been led to believe that fodder beets contained considerable amounts of

non-sucrose sugars that would greatly increase the total amount of sugars available for fermentation. This is a fallacy rather than a fact. Reducing sugars never exceeded 1 percent and usually were about one-fourth to one-third of 1 percent. Extremely higher yielding fodder beets frequently are very low in sucrose and their total sugar yield is significantly lower than varieties that have had some introgression of sugarbeet germplasm into them. The highest yielding fodder beet varieties tested this year were actually sugarbeet X fodder beet hybrids.

Conclusions

1. Fodder beets had significantly higher root weight than sugarbeets.

2. The sugarbeet check varieties had significantly greater sucrose percentage than fodder beets.

3. Reducing sugars, although greater in fodder beets, accounted for less than 1 percent of the total sugar in any of the varieties tested.

4. Varieties that have less than approximately 12 percent sucrose content do not yield sufficient total sugar yield to be a potential for a "fuel beet."

5. Very few fodder beet varieties were significantly better than the GWD2 universal check or the local check at any location in total sugar production.

6. There was a significant variety by location interaction for root yield, top yield, and total fermentable sugar yield.

B. INTERMOUNTAIN UNIFORM TRIAL OF EUROPEAN FODDER BEET VARIETIES

Twelve European fodder beet varieties and two commercial sugarbeet check varieties, GWD2 produced by Great Western Sugar, and AH10 produced by Amalgamated Sugar, were planted for evaluation in replicated field experiments at Logan, Utah; Fillmore, Utah; and Prosser, Wash. Six replicates of 4-row plots, 56 cm (22 inches) apart and 5 m (17 feet) long, were planted at each location. The characters studied and the methods for their determination were the same as cited for the national uniform fodder beet trials.

Results

Excellent stands and good plant growth was observed for both the Logan and Rexburg locations. At Fillmore, we experienced a heavy infestation of curly top disease that may have affected the reliability of the data as far as evaluating it for total yield. However, it was a valid test demonstrating the effects of curly top, to which all fodder beets are highly susceptible. One variety, Camobarres, was not harvested at the Fillmore location due to the poor plot stands resulting from the curly top infection. Curly top disease was so serious in the Prosser test (fodder beets had over 80 percent severely infected or dead plants) that it was abandoned without taking any harvest data.

Fodder beets were significantly higher than sugarbeets for root weight at Logan (Table 8), and Rexburg (Table 9). At Fillmore, the sugarbeets and fodder beets had similar root yield (Table 10). This, no doubt, was due to the curly top resistance of the sugarbeet varieties versus the susceptibility of fodder beets to this disease. Fodder beet root yields ranged from 72.15 to 101.94 metric tons per hectare (32 to 45 T/A) at Logan, and 75.05 to 111.31 metric tons per hectare (33 to 50 T/A) at Rexburg. The sugarbeets had larger top weights than part of the fodder beet varieties and equal top weight with others. The average top weight at both Logan and Rexburg was 84 percent of the GWD2 check. Sucrose percent was significantly higher for the sugarbeet varieties at all locations. Monofix and Cimarosa varieties were the fodder beets with the highest sugar percentage at each of the locations, averaging 83 to 89 percent of the sugar percentage of the GWD2 check.

Table 8. Root, top, sugar, and potential alcohol yield of European fodder beet varieties in intermountain regional test, Logan, Utah, 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A [1/]
GWD2	64.92	56.65	16.58	0.17	10.76	686
AH14	57.71	51.11	15.34	0.17	8.84	563
Meka Otofte	84.45	34.74	13.53	0.23	11.43	728
TC5/22-3	95.02	48.00	11.62	0.25	11.01	702
Monorosa	80.12	54.83	13.35	0.21	10.71	682
Monoparte	101.82	37.89	10.53	0.29	10.71	682
Monofix	77.76	49.50	13.71	0.15	10.66	679
Monoblanc	82.95	56.76	12.31	0.25	10.22	651
Barb 79-1	92.12	56.76	11.05	0.24	10.11	644
Cimarosa	72.15	52.49	13.78	0.16	9.94	633
Solanka	87.33	39.66	11.00	0.27	9.61	612
Camobarres	101.94	35.61	9.14	0.37	9.31	593
Zentaur	99.77	46.78	8.93	0.39	8.90	567
Monoborris	95.74	48.23	9.26	0.35	8.84	563
Mean	85.27	47.79	12.15	0.25	10.07	642
LSD .05	7.99	7.11	0.78	0.07	1.06	68
C.V.	8.11	12.89	5.27	25.45	9.12	9.12

[1/] To convert to liters/hectare, multiply by 9.35.

Fodder beets were higher in reducing sugars than sugarbeet; however, at every location, the reducing sugars did not exceed one-half of 1 percent. Thus, reducing sugars contribute very little to the total sugar yield. The sugarbeet check varieties exceeded all of the fodder beet varieties in total sugar yield at Fillmore. Two fodder beet varieties produced at Logan produced 2 and 3 percent greater sugar yield than the GWD2 check. The fodder beet variety

Monofix produced 12 percent (statistically significant) more total sugar than GWD2 at Rexburg. Five other varieties had sugar yield greater than the check, ranging from 2 to 8 percent higher. The estimated alcohol yield was 563 to 728 gallons per acre at Logan, 605 to 747 gallons per acre at Rexburg, and 508 to 772 gallons per acre at Fillmore. Dry matter content of fodder beet varieties was similar to that noted in European fodder beet trials. There were very few differences between the two check varieties in their yield, dry matter, or impurity contents.

Table 9. Root, top, sugar, and potential alcohol yield of European fodder beet varieties in intermountain regional test, Rexburg, Idaho, 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A [1/]
GWD2	65.73	64.53	15.87	0.23	10.44	665
AH14	57.83	57.85	16.65	0.23	10.97	699
Monofix	83.47	58.12	14.11	0.24	11.73	747
Cimarosa	79.84	56.89	14.12	0.31	11.24	716
Barb 79-2	98.01	62.69	11.43	0.24	11.24	716
Monorosa	79.77	56.52	13.54	0.22	10.80	688
Monoblanc	85.92	60.07	12.45	0.29	10.71	682
Meka Otofte	75.05	38.30	13.55	0.27	10.68	681
Camobarres	111.31	51.49	9.43	0.34	10.48	668
Solanka	89.77	43.88	11.59	0.28	10.36	660
TC5/22-3	88.59	48.76	11.57	0.36	10.20	650
Zentaur	110.33	56.81	8.95	0.46	9.85	628
Monoparte	97.05	45.75	10.08	0.40	9.78	623
Monoborris	94.83	49.89	10.09	0.30	9.50	605
Mean	87.82	53.90	12.39	0.30	10.57	673
LSD .05	7.18	10.69	1.16	0.08	1.19	682
C.V.	7.08	17.17	8.09	22.92	9.76	9.76

[1/] To convert to liters/hectare, multiply by 9.35.

It was noted that high root yield varieties as Camobarres and Zentaur had the lowest sugar percentage of fodder beet varieties. Fodder beet varieties that gave the greatest total sugar, i.e., Monofix, Cimarosa, and Barb 79-1, are European sugarbeet X fodder beet hybrids. This suggests that the best potential for a "fuel beet" will be a sugarbeet X fodder beet hybrid, and not a fodder beet per se.

Table 10. Root, top, sugar, and potential alcohol yield of European fodder beet varieties in intermountain regional test, Fillmore, Utah, 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A [1/]
GWD2	75.65	20.10	16.00	0.13	12.11	772
AH14	75.95	23.08	15.82	0.13	12.03	767
Monofix	80.11	12.22	13.62	0.19	10.83	690
Barb 79-1	100.93	15.42	10.57	0.26	10.64	678
Cimarosa	76.86	9.20	13.34	0.26	10.24	652
Monoblanc	78.24	11.46	12.57	0.28	9.86	628
Monorosa	74.74	12.61	12.74	0.21	9.47	603
Meka Otofte	70.17	8.77	13.21	0.23	9.18	585
Solanka	74.86	8.39	12.20	0.19	9.12	581
TC5/22-3	75.71	8.02	11.67	0.42	8.79	560
Monoparte	80.58	5.75	10.37	0.43	8.35	532
Monoborris	81.62	7.50	10.13	0.39	8.30	529
Zentaur	76.81	6.83	10.41	0.56	7.98	508
Mean	78.63	11.49	12.51	0.28	9.76	622
LSD .05	14.60	4.86	1.08	0.11	1.83	117
C.V.	16.08	36.59	7.50	33.01	12.60	12.60

[1/] To convert to liters/hectare, multiply by 9.35.

Conclusions

1. Fodder beets have higher fresh root weight than sugarbeets, mainly due to their high water content.

2. Sugarbeets have higher sucrose percentage and dry matter in the root.

3. One sugarbeet X fodder beet hybrid, Monofix, was the only fodder beet variety to yield significantly higher sugar and potential alcohol than the GWD2 commercial sugarbeet hybrid.

C. MISCELLANEOUS FODDER BEET FIELD EVALUATION EXPERIMENT

This test consisted of a sugarbeet check variety (GWD2), a high sugar content hybrid (LHS-1), and 28 fodder beet varieties received from Europe that had not been used in other field experiments. Three replicates of 2-row plots, 56 cm (22 inches) apart and 6 m (20 feet) long, were planted on the experiment station farm at Aberdeen, Idaho. The same varieties were also planted in four replicates of 4-row plots, 6 m long, at Logan. Only the center rows were harvested at Logan while the entire plot was harvested at Aberdeen. Methods of harvest, sampling, and laboratory determinations were otherwise similar to the other

experiments cited in previous subsections of this report.

Results

Excellent stands and growth were observed during the entire season at both locations. Only a rare plant showed curly top symptoms. Otherwise, there was no observable adverse effect of diseases or insects on these field trials. Root yield of fodder beets exceeded that of the sugarbeets as had been observed in other fodder beet yield trials (Tables 11 and 12). Fodder beet root yields ranged from 67.85 to 118.68 metric tons per acre (30 to 53 T/A) at Aberdeen. The sugarbeet varieties were significantly higher in sucrose percentage and were slightly lower in reducing sugar percentage, as also observed in other fodder beet field trials. The high sugar check LHS-1 was significantly higher than GWD2 for sucrose percentage at Aberdeen.

Eleven fodder beet varieties exceeded the total sugar yield of the sugarbeet checks by 1 to 14 percent at Logan. At Aberdeen, 15 fodder beet varieties had sugar yields greater than GWD2. Only two hybrids at Aberdeen, TC5/45-9, Krake, and one variety at Logan, Trestel, were significantly higher in total sugar yield than the commercial sugarbeet check. Potential alcohol yield at Logan ranged from 480 to 780 gallons per acre. The potential alcohol calculated for the Aberdeen location was 528 to 1,002 gallons per acre.

It was noted that the fodder beet varieties that gave the highest sugar yield, such as Trestel, Lamono, Monovert, Hugin, Monorosa, Prototype 2n Rose, etc., were sugarbeet X fodder beet hybrids. Fodder beet varieties that did not have an integression of sugarbeet germplasm were usually among the highest in root yield, and among the lowest in sucrose percentage.

Varieties such as Yellow Eckendorfer, Mammoth Red, Peramono, Poly Blanche, and Ursus, that have low sucrose percentage (6 to 8 percent) regardless of root weight, produced less total sugar than sugarbeet. Significant differences were observed between locations and for genotype X fodder beet interactions.

Conclusions

1. Fodder beets produce significantly higher root yield than sugarbeets.

2. Sugarbeets are significantly better in sucrose percentage.

3. Reducing sugar percentages are less than 1 percent and, therefore, contribute relatively little to the total sugar yield and potential alcohol production.

4. Disease resistant adapted sugarbeet X fodder beet hybrids offer the greatest potential for a "fuel beet."

Table 11. Root, top, sugar, and potential alcohol yield of miscellaneous European fodder beet varieties, Logan, Utah, 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A [1/]
GWD2	65.58	47.49	16.35	0.17	10.74	684
LHS-1	58.21	37.45	17.17	0.18	9.97	635
Trestel	89.72	50.88	13.67	0.15	12.24	780
Lamono	106.55	37.33	11.23	0.31	11.90	758
Monovert	90.54	40.58	12.89	0.26	11.66	743
Hugin	89.04	49.13	13.07	0.22	11.63	741
Proto 2n Rose	92.91	38.24	12.38	0.23	11.49	732
TC5/45-9	101.17	46.06	11.27	0.25	11.41	727
TC2018	90.09	48.59	12.68	0.19	11.39	726
TC198	100.11	41.61	11.21	0.27	11.22	715
TC1157	91.87	44.64	12.12	0.29	11.13	709
Proto 3n Rose	84.71	43.75	13.10	0.22	11.09	707
Kimono	92.19	35.04	11.73	0.25	10.78	687
Barb 79-2	97.40	53.89	10.91	0.21	10.62	677
TC201	86.33	42.74	12.20	0.23	10.51	670
Monorosa	80.50	47.15	13.07	0.19	10.51	670
Vital Daehnfeldt	85.77	37.94	12.25	0.21	10.49	668
Majoral	105.41	46.68	9.95	0.36	10.49	668
Solar	96.35	35.81	10.92	0.25	10.47	667
Peroba	100.50	33.89	10.38	0.34	10.41	663
Proto 3n Blanche	79.11	38.83	13.11	0.18	10.32	658
Krake	78.45	45.26	13.20	0.24	10.28	655
Giant Half Sugar	118.68	27.87	8.66	0.28	10.22	651
Monoval	99.16	40.76	10.35	0.41	10.17	648
TC5014	99.41	51.91	10.12	0.21	10.07	641
TC1148	109.77	46.38	8.87	0.35	9.71	619
TC5001	86.72	45.57	11.21	0.27	9.53	607
Monobomba	84.48	40.92	11.23	0.29	9.50	605
TC1163	101.87	37.42	9.15	0.32	9.24	589
Beta Monogerm	67.85	48.12	13.57	0.20	9.21	587
Barb 78-1	91.92	37.84	9.96	0.29	9.10	580
Blanca	91.44	39.36	9.98	0.27	9.02	575
Ursus	101.85	35.53	8.89	0.34	8.98	572
Poly Blanche	113.14	38.42	7.95	0.62	8.93	569
Rose Beta	95.63	48.64	9.15	0.37	8.67	552
Peramono	102.09	27.26	8.22	0.33	8.38	634
Mammoth Red	112.61	37.22	7.60	0.56	8.38	534
Babl. Yellow Cyl.	74.73	44.48	10.27	0.18	7.66	488
Yellow Eckendorf.	115.72	18.13	6.60	0.87	7.54	480
Mean	92.67	41.25	11.19	0.29	10.10	644
LSD .05	13.04	8.87	1.01	0.11	1.43	91
C.V.	10.05	15.36	6.48	27.33	10.11	

[1/] To convert to liters/hectare, multiply by 9.35.

Table 12. Root, top, sugar, and potential alcohol yield of miscellaneous European fodder beet varieties, Aberdeen, Idaho, 1980.

Variety	Root Weight t/ha	Top Weight t/ha	Sucrose %	Reducing Sugar %	Sugar Yield t/ha	Potential Alcohol Yield Gal/A 1/
GWD2	79.15	84.70	16.56	0.19	13.11	835
LHS-1	67.26	53.26	18.80	0.18	12.64	805
TC5/45-9	132.78	73.29	11.85	0.24	15.72	1002
Krake	106.94	86.73	14.33	0.17	15.25	972
Monorosa	109.78	93.44	13.13	0.25	14.44	920
Proto 3n Blanche	113.96	66.40	12.56	0.16	14.25	908
Proto 2n Rose	111.80	59.17	12.71	0.21	14.18	904
Hugin	116.62	84.98	12.16	0.17	14.17	903
Monoval	129.80	60.76	10.87	0.32	14.10	898
Monobomba	124.29	78.71	11.41	0.23	14.10	898
Barb 78-1	141.98	83.89	9.92	0.28	13.98	891
Barb 79-2	131.80	85.39	10.65	0.20	13.96	890
TC201	122.04	84.64	11.14	0.23	13.48	859
Peroba	126.69	57.45	10.58	0.19	13.40	854
TC2018	98.19	56.68	13.60	0.17	13.34	850
Trestel	100.43	65.82	13.20	0.18	13.34	850
TC5001	124.28	76.89	10.70	0.23	13.20	841
TC5014	119.22	69.05	11.01	0.20	13.12	836
Kimono	109.42	56.16	12.00	0.20	13.12	836
TC1148	133.19	64.41	9.83	0.25	13.08	833
TC1157	108.90	62.80	12.03	0.25	13.05	832
Proto 3n Rose	105.37	65.38	12.42	0.21	13.02	830
Monovert	109.98	62.68	11.97	0.22	12.95	825
Vital Daehnfeldt	103.83	58.76	12.46	0.19	12.93	824
TC198	110.67	55.71	11.49	0.24	12.71	810
Ursus	152.45	76.16	8.07	0.30	12.30	784
TC1163	136.57	60.09	8.76	0.31	11.93	760
Majoral	131.10	76.30	9.00	0.29	11.74	748
Solar	119.59	63.62	9.74	0.24	11.61	740
Blanca	114.02	69.41	9.95	0.21	11.19	713
Peramono	143.54	59.60	7.76	0.27	11.13	709
Giant Half Sugar	131.76	44.20	8.17	0.34	10.75	685
Poly Blanche	146.36	59.22	7.35	0.62	10.52	670
Rose Beta	113.96	75.20	9.15	0.33	10.41	663
Beta Monogerm	82.16	57.06	11.59	0.23	9.83	626
Bab. Yellow Cyl.	100.17	77.37	9.80	0.19	9.73	620
Mammoth Red	127.97	53.38	7.62	0.34	9.72	619
Yellow Eckendorf.	130.61	34.71	6.36	0.53	8.28	528
Mean	117.59	67.20	11.07	0.25	12.63	805
LSD .05	6.62	17.74	1.83	0.10	2.06	131
C.V.	7.72	16.17	10.10	25.29	10.01	10.01

1/ To convert to liters/hectare, multiply by 9.35.

D. FUEL BEET BREEDING

Sugarbeet breeders have long been frustrated by a negative correlation between sucrose content and root yield. Selection for high sucrose content has generally led to reduced yields, or selection for high root yield has generally resulted in a reduced sucrose content. This negative correlation is not complete, i.e., it is generally between -0.50 and -0.80, and has allowed the plant breeder to improve yield while maintaining a relative high sucrose content. However, this negative correlation has significantly slowed or restricted the potential sugarbeet improvement that could have occurred if these two characters were independent.

In the development of new sugarbeet varieties, it is essential that a high sucrose concentration be maintained, as illustrated in Figure 1.

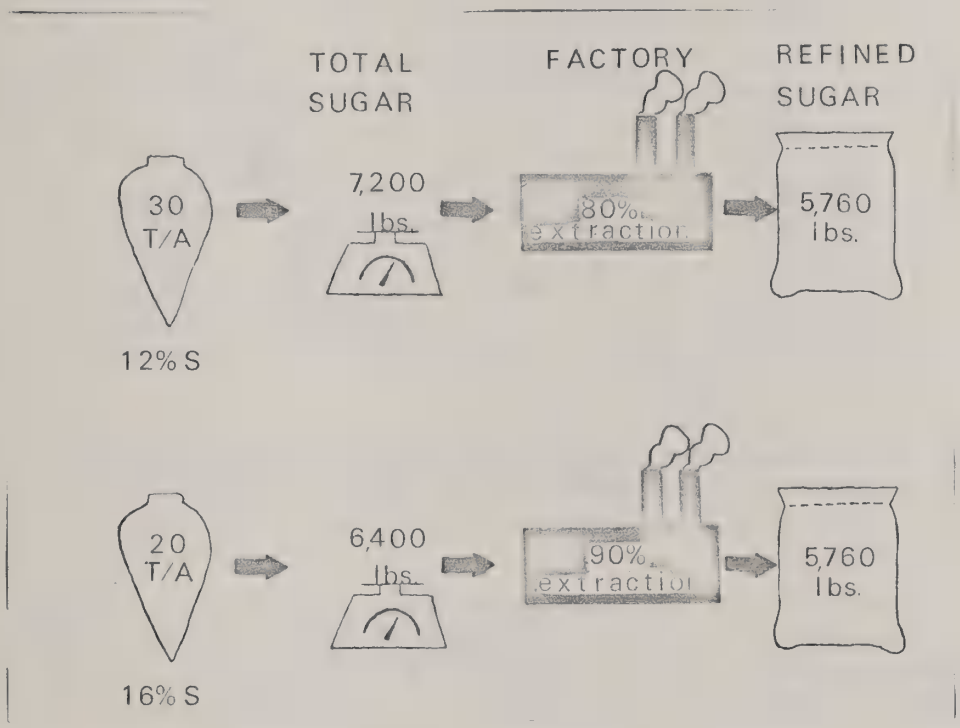

Figure 1. The theoretical refined sugar yield from a hypothetical sugarbeet and fodder beet.

Using a hypothetical situation of a 20-ton-per-acre sugarbeet with a 16 percent sucrose vs. a 30-ton-per-acre fodder beet with a 12 percent sucrose content, the low sucrose content fodder beet will produce about 800 more pounds of sucrose per acre than the sugarbeet. However, the sugar extraction rate of the low sucrose content fodder beet will be lower than the sugarbeet because of the lower sucrose content and other elements associated with low sucrose content (high nitrogen, sodium, and potassium). Using a hypothetical extraction rate of 80 and 90 percent for the fodder beet and sugarbeet respectively, the fodder beet will produce the same amount of refined sucrose as the sugarbeet even

though it produced 800 more pounds of total sugar.

If the same beets were used for alcohol fuel production, a different result is obtained (Figure 2).

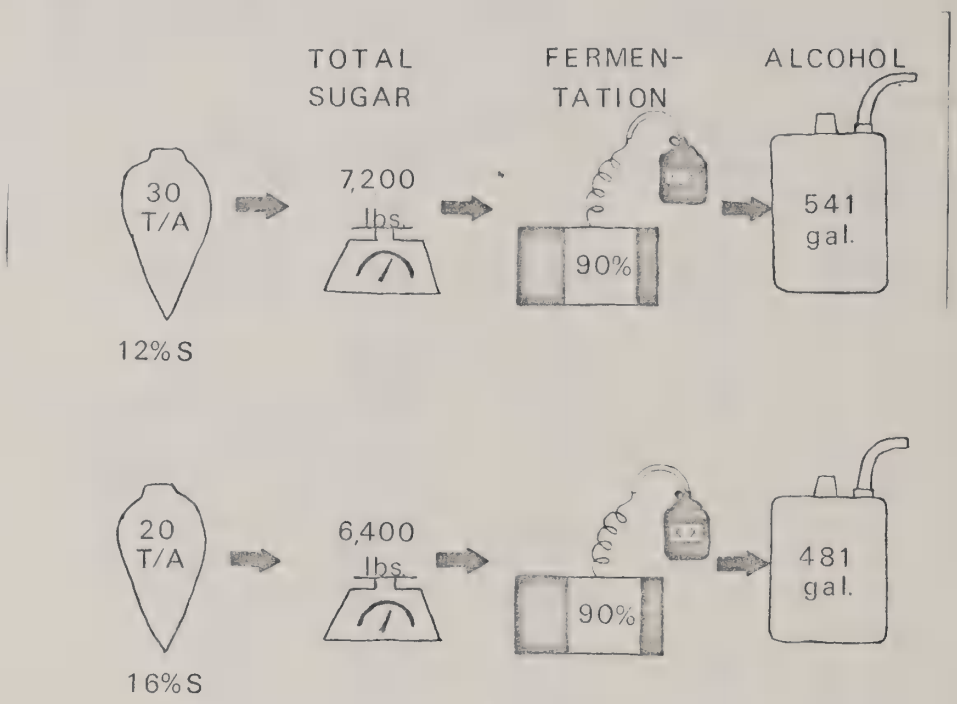

Figure 2. Theoretical alcohol yield from a hypothetical sugarbeet and fodder beet.

Fermentation is just as efficient in the low sucrose content fodder beet as the high sucrose sugarbeet. In fact, the high nitrogen, sodium, and potassium content associated with low sucrose content is beneficial for fermentation rather than harmful as in sucrose crystallization. The result is a potential of 60 more gallons of alcohol per acre with the fodder beet.

This suggests that maintaining a high sucrose content is unnecessary in breeding for a fuel beet. The negative correlation between root yield and sucrose content is less important, and to a degree, can be ignored. We, therefore, anticipate more rapid progress can be achieved in a fuel beet breeding program than has been experienced in our past sugarbeet breeding programs. The plant breeder can concentrate on total fermentable sugar production rather than being restricted with the necessity of maintaining high sucrose and low nitrogen, sodium, and potassium content.

Over the past few years, we have developed a number of broadbased "Beta" populations. One such population is f356, which contains germplasm from many different "Beta" types (sugar, mangle, fodder, red, and leafy). Several selections were made in this population for root and sugar types. These

selections were tested in a replicated field trial in 1980 (Table 13) along with the f356 broadbase parent and two commercial sugarbeet hybrids (GWD2 and AH10).

The round selection (h535) had a lower root yield than the parent, whereas the long hypocotyl selection (g226) exhibited a significantly reduced sucrose content. Reducing sugars were higher in the parent and one selection than the sugarbeet hybrids; however, the differences were too small to significantly affect the total sugar production. Quality factors were significantly higher in the broadbase populations and selections than in the sugarbeet hybrids. The high sugar selections (h536 and h537) had significantly higher sugars and about the same root yields as the parent. However, the best one (h536) yielded equal to but not more total sugar than GWD2. The most interesting and most promising selection was the high yield selection (g241). This was made for high root yield, ignoring sugar content. Its sugar content was about the same as the parent, but its root yield significantly exceeded the parent (about 9 tons per acre). It significantly exceeded the best sugarbeet hybrid (GWD2) in total fermentable sugar production by about 13 percent. It would be rejected as a good sugarbeet selection because of its low sucrose content and high sodium and potassium content; however, it would make an excellent fuel beet selection. This apparent 13 percent increase in total fermentable sugar production was achieved in one cycle of mass selection. It has the potential of producing 65 more gallons of alcohol per acre than the GWD2 sugarbeet hybrid.

The cost of producing the high yield selection would be more because of the increase in handling and hauling the increased tonnage. In order to evaluate this effect, the cost of each feedstock was determined by setting a base price of $600 to produce a 20-ton-per-acre crop plus an additional $2 per ton hauling cost for the additional yield over 20 tons per acre. This reduces some of the advantage of the high yield-low sugar selection; however, it still renders the feedstock cost about 9 cents per gallon less than the sugarbeet hybrid GWD2. Based on these results, it appears that significant progress can be achieved in breeding for a fuel beet.

Table 13. Yields, sugar content, impurity content, potential alcohol production and feedstock for a broad-base population, six selections, and two commercial sugarbeet hybrids.

Code	Type of Selection	Total Sugar t/ha	Root Yield t/ha	Sucrose %	Reducing Sugar %	Total Fermentable Sugar %	Na ppm	K ppm	Potential Alcohol Gal/A [a]	Cost Feedstock $/Gallon [b]
g226	Long Hypocotyl	7.34	60.49	11.70	0.46	12.16	539	2414	471	$1.30
g241	High Yield	10.05	77.86	12.57	0.34	12.91	488	2312	645	.97
h535	Round	6.77	53.09	12.37	0.36	12.73	572	2712	438	1.38
h536	High Sugar	8.99	64.37	13.60	0.37	13.97	524	2514	577	1.07
h537	High Sugar	8.33	56.74	14.26	0.32	14.58	452	2075	532	1.15
f355	Poly 2	7.48	56.16	13.01	0.34	15.35	431	2466	494	1.23
f356	Parent	8.16	62.14	12.75	0.40	13.15	516	2652	527	1.17
GWD2		8.88	51.96	16.86	0.29	17.15	172	1500	570	1.06
AH10		7.71	46.79	16.17	0.30	16.47	213	1697	495	1.21
F (40 df)		6.48	11.39	23.24	2.26	43.62	23.9	20.0		
LSD 0.05		1.11	7.55	0.90	0.09	0.74	86	268	70	
C.V. (%)		11.7	11.0	5.5	22.2	4.5	17.1	10.2		

[b] Based on $600/acre production cost plus $2/ton hauling cost over 20 tons/acre.

[a] Multiply by 9.35 to obtain liters/hectare.

E. EVALUATIONS FOR DISEASE RESISTANCE OF FODDER BEETS

D. L. Mumford

Sixty-nine fodder beet varieties from Europe were planted in two replications in the national USDA curly top disease nursery at Logan. They were evaluated for their curly top resistance based on standard techniques outlined by Mumford.[1/] Three check varieties were included in the nursery: AH10, a highly resistant commercial hybrid; GWD2, a moderately resistant commercial hybrid; and C1.36, a highly resistant experimental variety. Ratings were made on a scale of 0 to 9 (9 = dead plant). All of the fodder beets were extremely susceptible to this disease (Table 14). The variety Trestel (a sugarbeet X fodder beet hybrid) was the only one with a score below 5.

1/ Mumford, D. L. 1974. Procedure for inducing curly top epidemics in field plots. Jr. Amer. Soc. Sugar Beet Technol. (18)10:20-23.

Table 14. Curly top disease ratings of European fodder beet varieties, Logan, Utah 1980.

Variety	Curly Top Rating 1/	Variety	Curly Top Rating	Variety	Curly Top Rating
GWD2	4.0	Mammoth Long Red	6.5	Prototype 2n Rose	6.5
AH10	2.0	Giant Half Sugar	6.5	Prototype 3n Rose	6.5
C1.36	1.0	Monoval	6.0	Hugin	5.0
Blanca	6.5	Majoral	6.0	Krake	6.0
Yellow Daeno	6.5	Monovert	6.0	TC5/22-3	6.5
Peroba	6.5	Beta Monogerm	6.5	TC5014	6.5
Solanka	6.0	Poly Rose Sugar	6.5	TC5001	5.5
Monara	6.5	Babalonai Yellow Cyl.	6.5	TC198	5.5
Rota	7.0	Rose Beta	6.5	TC201	5.5
Monoparte	5.5	Monorosa	5.0	TC5/45-9	5.5
Geante Rouge	7.0	Monobomba	6.5	TC1148	6.5
Oscar	6.0	Monoblanc	6.5	TC1157	6.0
Camobarres	6.5	Monriac	6.0	TC1163	6.0
Trestel	4.5	Monosrover	6.0	TC2018	6.0
Rod Otofte	6.5	Polyploids Blanche	7.0	Ursus	6.0
Pajbjerg Korsroe	6.0	Barb 78-1	6.0	Zentaur	6.5
Hvid Gimsing	6.0	Barb 78-2	6.0	Lamono	5.5
Meka Otofte	6.5	Barb 79-1	6.5	Rosover	6.0
Pajbjerg I. P.	6.5	Barb 79-2	6.0	E. Verte	6.0
Hvid Daehnfeldt	6.0	Monovigor	5.5	Eck Rouge	7.0
Kyros	5.5	Cimarosa	6.5	Eck. Jaune	6.0
Monoborris	6.0	Monofix	5.0	Vauriac	6.0
Eckdobarres	6.0	Kimono	6.5	Jaune ol'Obendorf	6.0
Yellow Eckendorfer	6.5	Prototype 2n Rose	6.0	Rouge ol'Obendorf	6.0

1/ Rating on scale of 0 = healthy, to 9 = dead plant.

SUGARBEET RESEARCH

1980 Report

Section C

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION AND

GERMPLASM RELEASES AND REGISTRATIONS, 1980

HECKER, R. J. and E. G. RUPPEL. 1980. Rhizoctonia root rot of sugarbeet as affected by rate and nitrogen fertilizer carrier. J. Amer. Soc. Sugar Beet Technol. 20:571-577.

Four sugarbeet (*Beta vulgaris* L.) field experiments were conducted to measure effects of nitrogen (N) fertility and plant density on intensity of root rot caused by *Rhizoctonia solani* Kühn. Different N quantities, times of application, and forms were tested for effect on rhizoctonia root rot in simulated commercial growing conditions and in our standard late planted, inoculated nursery. These N variables had no consistent effect on intensity of root rot. Also, plant density was not a factor in disease intensity. There appears to be no evidence that excess N has any consistently beneficial effect on reduction or control of rhizoctonia root rot. Thus, these experiments indicated that sugarbeet producers in *Rhizoctonia* problem areas should use N fertility levels which optimize sucrose production.

HECKER, R. J. and E. G. RUPPEL. 1980. Release of sugarbeet germplasm FC 702/6.

FC 702/6 is a diploid, multigerm, self sterile line bred for resistance to root rotting strains of *Rhizoctonia solani*: It is a product of four cycles of mass selection and one cycle of recurrent selection from FC 702. Under severe Rhizoctonia exposure for 2 years, FC 702/6 had 75% harvestable roots, 42% symptomless roots, and a disease index of 2.4, compared to 54%, 20%, and 3.2 for FC 703, and 1%, 0%, and 6.3 for FC 901 (susceptible check), respectively. FC 702/6 has good general combining ability for root yield, sucrose content, and purity, and was released for potential use as a pollinator, or source of pollinators, in the development of Rhizoctonia-resistant hybrid varieties.

LASA, J. M., R. J. HECKER and B. MEDINA. 1979. Contamination and ploidy degradation in sugar-beet (*Beta vulgaris* L.). Ann. Aula Dei.

A study of the effect on ploidy level in three tetraploid (4*X*) populations contaminated by pollen from their source diploids (2*X*) revealed that after one generation of 2*X* x 4*X* interpollination progeny from 4*X* parent plants were 2.2% 4*X*, 96.7% 3*X*, and 1.1% 2*X*. Using random seed from 4*X* parents to produce plants which were again interpollinated with 2*X* plants, the progeny were 0.3% 4*X*, 21% 3*X*, 17.8% 2*X*, and 60.9% aneuploid. The succeeding generation was 0% 4*X*, 0.6% 3*X*, 87.5% 2*X*, and 11.9% aneuploid. The rate of diploidization was similarly rapid in each of the three populations. The hazards of having non-4*X* plants in 4*X* seed increases is apparent.

MARTIN, S. S., R. J. HECKER and G. A. SMITH. 1980. Aluminum clarification of sugarbeet brei extracts. J. Amer. Soc. Sugar Beet Technol. 20:597-609.

Aluminum chloride was compared to lead subacetate as a sugarbeet extract clarificant. Samples analyzed ranged from half fodder beets to high-sucrose sugarbeets. Concentrations of both sodium and potassium were nearly identical in the two extract types. Amino N concentration in aluminum-clarified extracts was greater than, but highly correlated with, comparable data in lead-clarified extracts. Betaine was largely destroyed by aluminum clarification. Polarimetrically determined sucrose concentration means in the two extract types differed statistically only for the half fodder beet. For any sugarbeet genotype likely to be encountered in commercial practice, aluminum clarified filtrates are satisfactory for determination of sucrose and several common impurity components.

RUPPEL, E. G., A. D. JENKINS and L. M. BURTCH. 1980. Persistence of benomyl-tolerant strains of *Cercospora beticola* in the absence of benomyl. Phytopathology 70:25-26.

In 1976 and 1977, 98-100% of *Cercospora beticola* isolates obtained from diseased sugarbeets near Willcox, AZ, growing in benomyl-, triphenyltin-treated, or nonsprayed fields grew in PDA containing 5 µg a.i. benomyl per milliliter. Benomyl-sensitive isolates from Colorado were inhibited completely by 0.1 µg benomyl per milliliter. In 1978, 100% of the isolates from a triphenyltin-sprayed field also were tolerant to 100 µg benomyl per milliliter. The level of tolerance declined considerably between 1976 and 1977. In 1976, all isolates from benomyl-sprayed and nonsprayed fields grew in PDA containing 1,000 µg benomyl per milliliter, whereas only 71% of the isolates from the triphenyltin-sprayed field grew at that concentration. In 1977, only 1, 1, and 0% of the isolates from benomyl-sprayed, nonsprayed, and triphenyltin-sprayed fields, respectively, grew in PDA with 1,000 µg benomyl per milliliter. All of the isolates from 1978 grew in PDA cultures containing benomyl at 10 µg/ml, but none grew in those containing 100 or 1,000 µg/ml. Most Arizona isolates of *C. beticola*, whether from sprayed or nonsprayed fields, were 100-1,000 times more tolerant to benomyl in vitro than were sensitive control isolates from Colorado over the 3-yr study. Thus, benomyl-tolerant strains of *C. beticola* showed a high degree of persistence in the absence of benomyl, even in fields where triphenyltin was used for leaf spot control.

Papers Which Have Been Published Since Being Abstracted in Previous Sugarbeet Research Reports

SMITH, G. A. Sugarbeet. Chapter 43 in Fehr, W. R. and H. H. Hadley (Ed.), Hybridization of Crop Plants. Am. Soc. Agron. Press, Madison. 1980.

SMITH, G. A. Registration of FC 607 and FC 607 CMS Sugarbeet Germplasm. (Reg. Nos. GP 60 and GP 61). Crop Sci. 20:419. 1980.

RHIZOCTONIA ROOT ROT RESEARCH AND RESISTANCE BREEDING
(BSDF Project 20)

1980 Rhizoctonia Field Research.--R. J. Hecker and E. G. Ruppel

Our 1980 field research on root rot of sugarbeet caused by *Rhizoctonia solani* was conducted on our BSDF-leased farm, where our cercospora leaf spot field research was also conducted.

The rhizoctonia root rot research was on an area of the farm reserved for that purpose, where the experiments are grown in a 4-year rotation (beets, barley, barley, fallow). Three 1980 experiments were located on part of the 1979 rhizoctonia field in order to have an area with a high residual rhizoctonia infestation. The three experiments on this residual inoculum area had received a preplant broadcast incorporated application of 50 pounds per acre of our standard barley grain inoculum. These experiments were planted May 5 and thinned June 5. These three experiments testing the effect of pesticides on rhizoctonia root rot, and biological control of Rhizoctonia are described in succeeding sections of this report.

The major Rhizoctonia test area in 1980 involving ten experiments was planted on an area with no residual rhizoctonia infestation, having been used last as a rhizoctonia root rot test area in 1976. There was no apparent Rhizoctonia infection in this portion of the 1980 nursery prior to inoculation. This area of ten experiments was inoculated July 22 in our standard manner. Dry, ground barley grain inoculum of *R. solani* was broadcast in a band over each row with a tractor-mounted 4-row granule applicator. The inoculum was applied at a rate of 1.3 grams per meter of row in a split application (opposite directions of travel for each application). Single-row plots, 6.1 meters (20 ft) long, and 56 cm (22 in) apart were planted May 14 and thinned about mid-June.

The roots in all experiments were lifted and individually rated for severity of rot September 15-19. Disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of rot; 7 = plant dead and extensively decomposed). The percentage of healthy roots were those with index ratings of 0 and 1, those roots having no or only small arrested lesions. The percentage of harvestable roots were those with DI ratings of 0 through 3; these were all roots sufficiently sound that would have been recovered in a commercial harvest. The epiphytotic in our 1980 nursery could be considered to be about ideal, with highly susceptible entries being killed due to *Rhizoctonia* by harvest time.

The succeeding reports in this section describe individual experiments in our 1980 rhizoctonia root rot research.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker

Separate randomized complete block designs with five replications were used to evaluate a total of 51 lines from American Crystal, Great Western, and Holly sugar companies, and from Hilleshog, Ltd. for resistance to *Rhizoctonia solani* in the field. In each test, Rhizoctonia resistant lines FC 703 and highly susceptible FC 901 were included for comparisons. Results of

each company's test were statistically analyzed and sent to company breeders; thus, they will not be reproduced here. The mean disease index (DI) across tests for FC 703 on a scale of 0 to 7 was 2.9; whereas, for FC 901 the mean DI was 5.9. The range in DI means for all company lines was 2.7 to 6.8. The mean % healthy roots (0 + 1 DI's) for FC 703 and FC 901 across tests were 33.5 and 0.8%, respectively; the mean for all company lines was 4.8%. The % harvestable roots (DI's 0 through 3) for FC 703 and FC 901 were 66.4 and 4.1%, respectively; the mean for company entires was 16.2%.

Breeding Program to Increase Resistance to Rhizoctonia Root Rot.--R. J. Hecker and E. G. Ruppel.

Reports of losses in the sugarbeet crop due to Rhizoctonia root rot have been received in 1980 from several of the major sugarbeet production regions of the United States. Although the intensity of the disease varies from year to year and region to region, there is a significant loss of sugarbeet production due to this ubiquitous root-rotting soil-borne fungus. Due to the low predictability of the intensity of the root rot problem from year to year, growers are understandably reluctant to accept varieties which sacrifice some yield in the absence of disease.

Our breeding program for resistance is designed to generate resistant germplasm potentially useful in the development of highly productive hybrid varieties. Both multigerm and monogerm germplasms are being developed and released. We are hopeful that they will find direct use as parents in successful hybrid varieties.

In 1980, FC 702/6 was released from our program. This resistant multigerm line was derived from FC 702. Under severe rhizoctonia exposure for 2 years, FC 702/6 had an average of 75% harvestable roots, 42% healthy roots, and a disease index of 2.4, compared with 54%, 20% and 3.2 for FC 703 (resistant check), and 1%, 0% and 6.3 for FC 901 (susceptible check), respectively. In limited tests it appears to have relatively good general combining ability for root yield, sucrose content, and juice purity. We are hopeful that FC 702/6 will find use as a pollinator or as a resistant source from which breeders might extract high combining pollinators.

The currently most attractive multigerm breeding lines are listed in Table 1. In this table are shown several lines which have potential as future releases, as well as a number of lines which have been released in the past.

Table 1. Assessment of intensity of rhizoctonia root rot on multigerm lines being developed for resistance and other lines, as measured by disease index (DI), % healthy roots, and % harvestable roots.

Entry No.	Breeding line	DI	% Healthy	% Harvestable
382	FC 705/2	2.6	25	71
388	FC 707/2	2.7	26	74
358	FC 705/1	2.8	26	74
389	FC 707/1	2.9	17	69
334	FC 705	3.0	15	67
381	FC 703/2	3.1	28	61
383	FC 702/6	3.1	24	62
397	FC 703/1	3.2	22	58
409	FC 701/5	3.2	17	57
362	Syn 2 from misc. RH sources	3.2	8	62
354	FC 702/7	3.2	23	61
371	FC 707	3.4	8	54
396	FC 703/4	3.4	15	32
402	FC 701/4	3.7	17	46
399	FC 702/5	3.7	14	46
398	FC 702/1	3.8	10	40
372	2 cy mass from EL 42	3.8	11	44
401	FC 701/3	4.1	12	32
336	FC 704	4.4	9	39
337	FC 702/4 (4X)	4.4	4	32
413	FC 702/4	4.4	4	26
411	FC 702	4.5	5	25
412	FC 702/2	4.5	7	23
373	EL 42	4.6	5	23
410	FC 701	4.8	3	21
326	FC 703; resistant check	3.9	4	37
327	FC 901; susceptible check	6.2	0	1
	LSD (.05)	0.67	9.6	10.5

Several of the lines from our program of monogerm incorporation are shown in Table 2. All of our resistant materials have originated from multigerm sources. We have incorporated the monogerm character from various monogerm parents, all of which have been susceptible to rhizoctonia root rot. The recovery of resistance by selection in segregating generations and back-crosses has been difficult. Thus far, FC 708 and FC 708 CMS are the only monogerm, type 0, male sterile rhizoctonia resistant releases we have made.

Table 2. Assessment of rhizoctonia root rot on monogerm or segregating lines, and commercial type materials.

Entry No.	Breeding line	DI	% Healthy	% Harvestable
	Monogerm or segregating			
375	OP from 24 S_1's of (FC 701 X mm,TO's)BC_1P_2	2.1	38	92
331	Com. of super. S_2's	2.2	42	85
330	S_2 from (FC 701 X mm TO's)	2.4	41	79
376	OP from 18 super. S_1's	2.4	41	80
360	Syn 2 from (FC 702 X mm TO's)	2.8	27	72
380	FC 708 CMS	2.9	21	67
361	Syn 2 from SP 5831-0	2.9	25	69
359	Syn 2 from (FC 701 X mm TO's)	3.3	17	64
353	Syn from SP 5831-0	3.4	14	53
335	FC 708 CMS X FC 705	3.4	15	53
370	FC 708	3.5	13	60
387	Syn 1 from (mm TO X FC 701)$B_1P_1OP_1$	3.7	12	45
369	Rh resist. mm, seg TO	4.3	9	38
365	Polish 2X - 4/73 X Rh. resist. TO, F_2	5.4	1	6
364	2d cy RH resist. sel. from USSR mm TO	5.8	0	1
	Commercial type materials			
332	EL 44 CMS X FC 708	4.5	3	20
385	HH 32	4.9	2	16
338	EL 43	4.9	4	17
333	1861 CMS X FC 708	5.0	1	12
368	FC 607 CMS	5.3	1	6
386	HH 33	5.5	1	9
367	FC 607	5.8	0	8
339	EL 44	6.5	0	1
340	563	6.6	0	0
326	FC 703; resistant check	3.9	4	37
327	FC 901; susceptible check	6.2	0	1
	LSD	0.67	9.6	10.5

Our most resistant germplasms have resulted from inbreeding in hybrid generations segregating for the monogerm character. In Table 2, the top four breeding lines for resistance have resulted from recombination of S_1 and S_2 lines identified as being superior for rhizoctonia root rot resistance. However, these best lines are not immune to root rot. The percentage of healthy roots (essentially symptomless) amounted to about 40% of the total population. However, 80-90% were classed as harvestable. Hence, there remains a need for further improvement in our breeding materials.

A new technique of exposure of the plants to the pathogen in both the root development and seed production stage has been carried on for two generations. However, only the first generation was under test in 1980. These results are described in a subsequent section of this Project 20 report.

The commercial-type materials listed in Table 2 primarily are lines which have not been tested previously, and are part of our continued search for indigenous high levels of resistance.

A considerable number of other germplasms were in this same test but are not included in the tables because they were not of significant interest.

Each succeeding year of results and observations from our testing, selection, and breeding programs reinforces our hypothesis that resistance to root rotting strains of *R. solani* is controlled by a number of genes in sugarbeet. In our resistant lines, we appear to have accumulated a number of these genes. This accumulated resistance appears to be horizontal, because practical important interactions to different *R. solani* strains have yet to be observed or reported.

Studies involving our resistant Ft. Collins germplasms as part of the assessment program of our resistant breeding lines continues to produce new experimental hybrids each year. The productivity of these hybrids under disease-free conditions is reported in a subsequent section of this report.

Yield Test of Best Rhizoctonia Resistant Experimental Hybrids.--R. J. Hecker and G. A. Smith

Part of our program of breeding and development of rhizoctonia resistant germplasms includes a preliminary assessment of general combining ability. Each of the new resistant developments are crossed with a set of cytoplasmic male sterile (CMS) monogerm lines. These experimental hybrids are then assessed in a preliminary combining ability test. In evaluating these hybrids we detect a few hybrids which display relatively good specific combining ability for sucrose production. We then include these better hybrids for further testing in succeeding years. The disease-free yields of these better hybrids tested in 1980 are summarized in Table 1. Those few hybrids which show the greatest promise are reentered into the test for one or two additional years. Hence, four of the hybrids in Table 1 include results of their tests in 1979 and 1978.

All the data shown in Table 1 were from disease-free experiments at the CSU Agronomy Research Center planted April 15-27. They were grown in randomized complete block designs with 5-row plots, 25 feet long, with rows 2, 3, and 4 being harvested. The results in Table 1 indicate that some of the rhizoctonia resistant pollinators have relatively good specific combining ability, especially since the resistant pollinators have been developed essentially for resistance with little regard for combining ability. These experimental hybrids in Table 1 were generally not significantly different from the check (Mono Hy D2) for recoverable sucrose or the sucrose yield components. They were for the most part higher in sucrose content and thin juice purity than the check, but were generally lower than the check for root yield so that the recoverable sucrose was usually not significantly different than the check. These same experimental hybrids were included

Table 1. Disease-free performance of rhizoctonia resistant experimental hybrids, and disease indices (DI) in inoculated tests.

	DI		Recoverable sucrose (T/A)					Root yield (T/A)					Sucrose %					Thin juice purity %				
	80	79	80	79	78	79-80 $\bar{x}$	78-80 $\bar{x}$	80	79	78	79-80 $\bar{x}$	78-80 $\bar{x}$	80	79	78	79-80 $\bar{x}$	78-80 $\bar{x}$	80	79	78	79-80 $\bar{x}$	78-80 $\bar{x}$
FC 603 CMS x Syn of FC 703	4.3		3.05	3.48	2.43	3.26	2.99	25.2	25.0	20.6	25.1	23.6	14.9	17.3	14.7	16.1	15.6	86.5	90.2	89.8	88.4	88.8
(562 CMS x 546) x Phoma sel from FC 701/4		3.5	2.97	3.41	2.45	3.19	2.94	28.2	24.7	22.5	26.5	25.1	13.1	17.2	14.0	15.2	14.8	84.7	90.2	89.6	87.5	88.2
(FC 504 CMS x FC 502/2)X FC705		3.9	2.81	3.34	2.29	3.08	2.81	24.0	24.7	20.1	24.4	22.9	14.5	17.0	14.5	15.8	15.3	85.6	89.1	89.8	87.4	88.2
FC 3-way CMS x FC 703		4.4	2.80	3.30		3.05		24.0	24.5		24.3		14.3	16.9		15.6		86.9	89.9		88.4	
(562 CMS x 546) x FC 705	4.0		2.86					29.2					12.2					81.7				
FC 2-way$_1$ CMS x FC 707/1	4.5		2.71					25.2					13.4					84.2				
FC 2-way$_1$ CMS x FC 702/6	4.4		2.76					24.4					14.0					85.8				
(1861 CMS x 12166) x FC702/5	4.7		3.03					24.9					15.0					87.5				
FC 607 CMS x Aula Dei	-	-	2.84					22.5					15.5					87.6				
FC 2-way$_2$ CMS X FC 705	3.9		3.14					30.1					12.9					83.6				
FC 2-way$_2$ CMS X FC 707/1	4.6		3.04					29.0					13.0					84.2				
(562 CMS X 546) X FC 702/6	4.1		2.85					25.8					13.7					85.6				
HH 32	4.3	5.3	3.07					27.3					13.9					85.8				
Mono Hy D2; yield check	5.1	6.2	2.99	3.52	2.97	3.26	3.16	27.2	25.4	24.9	26.3	25.8	13.6	16.9	14.8	15.3	15.1	84.6	90.8	90.2	87.7	88.5
FC 703; rhizoc. resist. check	2.8	2.6																				
LSD $_{.05}$	0.6	0.9	0.32	0.26	0.34			3.2	1.9	2.2			0.8	0.5	0.8			2.0	0.8	1.3		

in the rhizoctonia root rot test either in 1979 or 1980 and the resulting disease indices are also shown in Table 1. All but two of the experimental hybrids are significantly more resistant than the yield check. However, all are significantly more susceptible than the resistant check, FC-703. These disease indices indicate a more-or-less mid-parental value for hybrids between susceptible and resistant germplasms.

Some of these experimental hybrids might be directly useful in areas where rhizoctonia root rot is a chronic problem. Also, better hybrid combinations of these pollinators with other male steriles might be found. If any of the specific experimental hybrids shown in Table 1 are of interest to any of our BSDF cooperators, we do have a limited quantity of hybrid seed which could be distributed for 1981 field testing in their localities. The majority of the pollinators used in these hybrids have been released to BSDF cooperators. The other pollinators will be soon released, or could be released on request.

Preliminary General and Specific Combining Ability Test for Sucrose Yield of Rhizoctonia Resistant Experimental Hybrids.-- R. J. Hecker and G. A. Smith.

In this 1980 preliminary combining ability test of rhizoctonia resistant pollinators, we crossed a set of nine susceptible monogerm male sterile females with seven resistant pollinators. The resulting hybrids were grown in a disease-free test at the CSU Agronomy Research Center using single-row plots in a triple lattice design with six replications.

The performance of the best individual hybrids is shown in Table 1. These 20 hybrids were all higher in recoverable sucrose than the check (Mono Hy D2), although not significantly. These are individual hybrids which had relatively good specific combining ability. These better hybrids appear to have relatively good production considering the relatively strong selection and breeding emphasis for rhizoctonia resistance. Further information on the parents involved in these hybrids, and also limited quantities of seed are available to those who might be interested in testing them in rhizoctonia problem areas. The CV's in this test were 12.8, 11.3, 5.3, and 1.4 for recoverable sucrose, root yield, sucrose percent, and thin juice purity percent, respectively.

Table 1. The most superior experimental hybrids in the 1980 disease-free test combining ability test of hybrids involving Rhizoctonia resistant pollinators.

Entry	Hybrid	Recov. Sucrose (T/A)	Root yield (T/A)	Sucrose %	T. J. purity %
853	(A74-65 CMS X EL 44) X FC 703/4	3.05	27.8	14.5	87.6
867	(A74-65 CMS X SP 73447-0) X FC 705	3.00	28.9	13.9	86.0
826	(652016sl CMS X 662119s1)X FC 702/7	2.98	26.7	15.1	87.9
864	(A74-65 CMS X EL44) X FC 702/7	2.91	29.9	13.8	85.4
807	(652016s1 CMS X 662119s1) X Syn from SP 5831-0	2.91	31.1	13.0	85.2
822	(FC 506 CMS X L36) X Syn GH Rh sel from FC 703	2.91	27.2	14.6	87.3
871	(A74-65 CMS X French mm) X FC 703/4	2.89	26.8	14.5	86.9
866	(FC 604 CMS X Polish PI372277) X FC 702/7	2.89	28.5	13.9	85.6
870	(A74-65 CMS X A74-66) X FC 702/7	2.89	27.0	14.3	87.2
809	(FC 604 CMS X Polish PI 372277) X FC 703/4	2.81	25.7	14.6	87.8
838	(A74-65 CMS X SP 73447) X FC 703/4	2.81	27.2	14.1	86.6
869	(A74-65 CMS X EL 44) X FC 705	2.81	26.9	14.4	86.6
833	(FC 506 CMS X EL 44) X FC 703/4	2.80	26.9	14.3	87.0
812	(A74-65 CMS X A74-66) X FC 705	2.79	27.8	14.1	86.3
848	(A74-65 CMS X A74-66) X FC 703/4	2.78	26.2	14.5	86.4
836	(FC 605 CMS X French mm) X Syn from SP5831-0	2.76	28.7	13.6	85.4
850	FC 708 CMS X EL 44	2.74	23.6	15.4	88.5
814	(652016s1 CMS X 662119s1) X FC 703/4	2.74	27.3	13.8	86.7
835	(652016s1 CMS X 662119s1) X FC 705	2.71	29.5	13.4	84.5
805	(FC 506 CMS X L36) X FC 702/4(4X)	2.71	28.7	13.6	85.3
	Mono Hy D2 (check)	2.66	26.0	14.2	86.1
	LSD (.05)	0.40	3.3	0.9	1.5

A preliminary general combining ability assessment of the seven resistant pollinators in this test is made in Table 2. The means of these seven sets of hybrids with common pollinators is not a broad assessment of general combining ability, but the nine CMS females involved do have a certain amount of genetic diversity. We feel this array of means provides some indication of general combining ability of these seven pollinator lines. FC 702/7 and FC 703/4 would appear to have some potential as pollinators. FC 705 produces hybrids generally with high root yield but somewhat lower sucrose and purity. All three of these lines have quite good resistance to rhizoctonia root rot with DI's of 3.2, 3.4, and 3.0, respectively, compared to our standard resistant check, FC 703, at 3.9.

The rhizoctonia resistance of the most productive hybrids in this test will be tested for rhizoctonia resistance in 1981. Past experiments indicate that the rhizoctonia resistant pollinators should impart sufficient resistance when hybridized with susceptible females so that resulting hybrids, if shown to be sufficiently productive, should be potentially useful in rhizoctonia root-rot problem areas.

Table 2. Means for recoverable sucrose and its components of sets of hybrids in which the respective Rhizoctonia resistant lines were pollinators (disease-free test), and disease indices (DI) of the pollinators in a Rhizoctonia inoculated test.

Resistant pollinator	DI	Recov. sucrose (T/A)	Root yield (T/A)	Sucrose %	T. J. purity %
FC 702/7	3.2	2.71	26.3	14.2	86.4
FC 703/4	3.4	2.68	25.7	14.3	86.6
FC 705	3.0	2.59	26.9	13.8	85.3
Syn GH Rh sel from FC 703	3.1	2.56	24.4	14.4	87.1
FC 702/4 (4X)	4.4	2.54	25.6	14.0	85.8
Syn from SP 5831-0	3.4	2.50	27.6	13.2	84.9
Syn from (FC 701 X mm LSR-CTR)	2.8	2.40	21.6	15.0	87.6

Rhizoctonia Resistance of Hybrids Relative to Their Susceptible and Resistant Parents.--R. J. Hecker & E. G. Ruppel

In order to obtain further information about the relative dominance of Rhizoctonia resistance, we had an inoculated field experiment in 1980 involving the most productive experimental hybrids from the 1979 preliminary combining test, along with their susceptible CMS female and pollinator parents. In this experiment, we used single-row 6.1 m (20-foot) plots with four replications in a randomized complete block design. All other methods were described in the first part of this section on *Rhizoctonia* research.

In examining the disease indices of the six hybrids in Table 1 from which mid-parental comparisons were available, the mean DI of 4.3 was only

Table 1. *Rhizoctonia* resistance comparisons of hybrids with their susceptible and resistant parents and midparental values (MP).

	Disease Index				% Healthy				% Harvestable			
	Hybrid	MP	Susc. Female	Resist. Male	Hybrid	MP	Susc. Female	Resist. Male	Hybrid	MP	Susc. Female	Resist. Male
(562 CMS X 546) X FC 705	4.0	4.2	6.2	2.3	10	20	0	40	31	40	5	76
FC 2-way$_1$ CMS X FC 707/1	4.5	4.2	6.0	2.4	3	20	0	40	18	38	0	76
FC 2-way$_1$ CMS X FC 702/6	4.4	4.3	6.0	2.6	4	19	0	38	8	37	0	75
(1861 CMS X 12166) X FC 702/5	4.7	4.9	6.7	3.0	2	16	0	33	17	27	2	53
FC 2-way$_2$ CMS X FC 705	3.9	-	-	2.3	7	-	-	40	26	-	-	76
FC 603 CMS X FC 703	4.3	4.9	6.8	2.9	6	12	0	25	14	29	0	59
FC 2-way$_2$ CMS X FC 707/1	4.6	-	-	2.4	4	-	-	40	11	-	-	76
(562 CMS X 546) X FC 702/6	4.1	4.4	6.2	2.6	6	19	0	38	31	40	5	75
Mean	4.3	4.5	6.3	2.6	5	18	0	36	20	35	2	69
HH 32	4.3				7				18			
Mono Hy D2	5.1				1				4			
LSD (.05)	0.6				3				4			

slightly less than the mid-parental DI of 4.5; hence, there was very little dominance for resistance in this set of susceptible X resistant hybrids. The mean mid-parental value for percentage healthy and percentage harvestable roots in Table 1 does not correspond as well with the obtained hybrid performance. However, for genetic interpretation, it is best to look at the disease indices because these data are on an essentially continuous scale, whereas the percentage healthy and harvestable roots are each classed into two discreet categories. From the DI, we must conclude that there was little or no evidence of dominance for resistance.

It appears from several experiments over several years that rhizoctonia resistance in the resistant breeding lines which we have developed is essentially intermediate, with only slight evidence of partial dominance for resistance. From earlier evidence of hybrids between susceptible diploids and resistant tetraploids, the resulting triploid hybrids with two genomes from the resistant parent definitely tend to have a greater level of resistance to *Rhizoctonia*. It seems advisable for a breeder to make and test diploid hybrids, then, for those hybrids which have the productivity potential to become varieties, convert the resistant pollinator to the tetraploid condition in order to produce a triploid hybrid with two genomes from the resistant parent.

Effect of Three Systemic Insecticides and Two Flowable Sulfurs on Disease Intensity of Rhizoctonia Root Rot in the Field.--E. G. Ruppel and R. J. Hecker.

A randomized complete block design with three replications was used to test the effect of carbofuran ('Furadan'; 9 kg product/acre), aldicarb ('Temik'; 7 kg product/acre), and phorate ('Thimet'; 7 kg product/acre) on the incidence and severity of rhizoctonia root rot. Additionally, flowable sulfurs 'THAT' and 'TOP COP' at 19 liters, product/acre, were included to test their efficacy in controlling the disease. Test cultivars included resistant FC 703 and intermediately resistant commercial hybrid HH 32. An area of our field nursery heavily infested with *Rhizoctonia* was chosen for the study; plot size was the same as in the herbicide study. To increase our precision in evaluating the effect of systemic insecticides on root rot severity, a combined analysis of variance was performed on the data from our 1979 and 1980 experiments (error variances from separate ANOV's were homogeneous). As expected, significant differences were found between years and cultivars, and among treatments; however, there were no significant interactions between years and treatments, or treatments and cultivars. Thus, the treatment response in both cultivars was similar in both years.

Figure 1 graphically shows the treatment effects across both cultivars in regard to disease index (DI) and % harvestable roots as compared with the nontreated control. The DI's for phorate (4.5) and aldicarb (4.0) were significantly higher than that of the control (3.4). The DI for carbofuran (3.8) was not significantly different from that of aldicarb or the control, but was significantly lower than that of phorate. In % harvestable roots, only phorate (37.5%) was significantly lower than the control (55.9%), but carbofuran and aldicarb also tended to reduce harvestable roots by 6 and 8%, respectively.

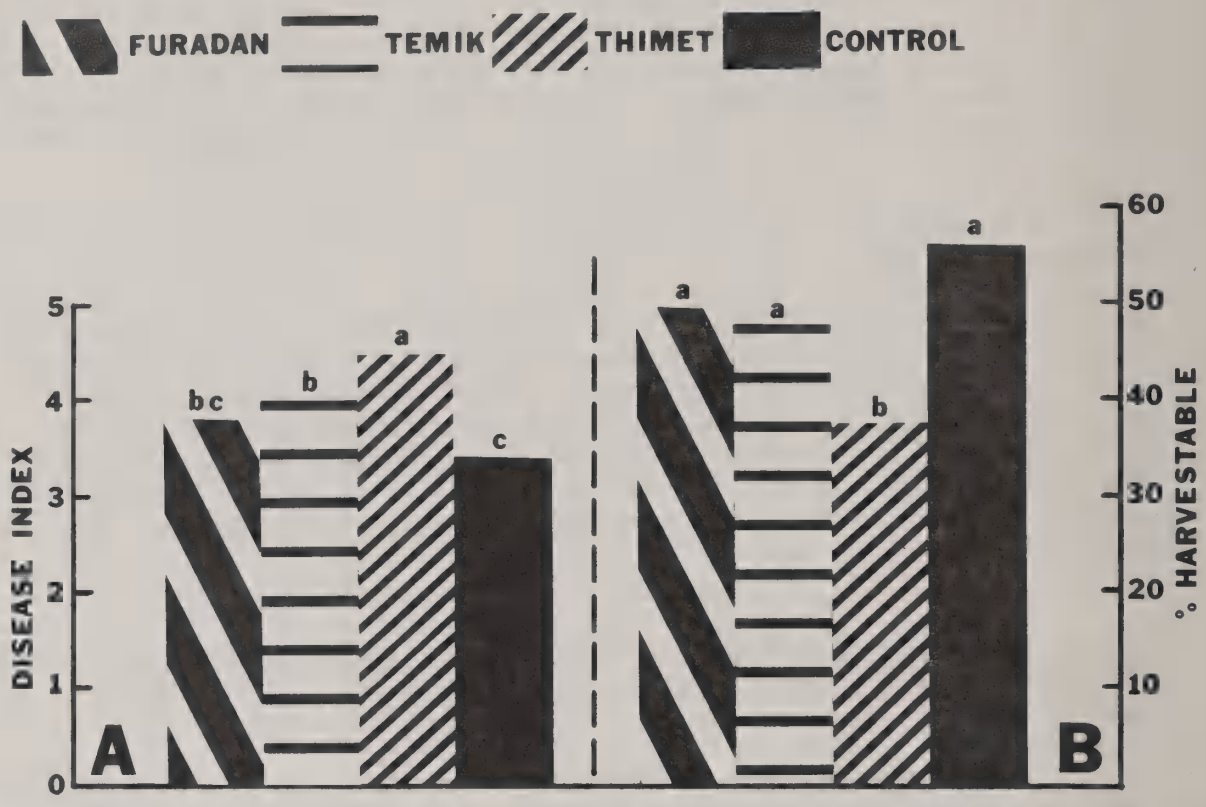

Figure 1. Effect of three systemic insecticides on the development of rhizoctonia root rot across two sugarbeet cultivars in the field. A) Disease index on a scale of 0 to 7, with 0 = no rot and 7 = plant dead. B) % harvestable roots derived by combining disease index classes 0, 1, 2, and 3. Bars within each graph topped with the same letter are not significantly different at $P = 0.05$ according to Duncan's multiple range test.

Figure 2 presents the DI's and % harvestable roots individually for each cultivar. Phorate similarly increased the DI and reduced harvestable roots in both cultivars, whereas the effect of aldicarb was only observed in HH 32. The effect of carbofuran was slightly greater in FC 703 than in HH 32.

Both flowable sulfurs significantly reduced the DI's across both cultivars; however, differences in % harvestable roots were not significant, although they ranged from 19.5 to 22.6% (Figure 3).

The effects of both sulfurs on the DI's and % harvestable roots of the individual cultivars are presented in Table 1. Both compounds showed a greater effect on the DI's and harvestable roots of HH 32 as compared with FC 703. Increases in harvestable HH 32 roots were 23 and 27% for 'THAT' and 'TOP COP', respectively, whereas the treatments increased harvestable roots of FC 703 only 14 and 16%, respectively.

Table 1. Effect of two flowable sulfurs on the severity of rhizoctonia root rot in two sugarbeet cultivars in the field.

Cultivar	Treatment[1/]	Disease index[2/]	% Harvestable[3/]
FC 703	THAT	1.6	89
	TOP COP	1.7	91
	Control	2.4	75
HH 32	THAT	2.9	65
	TOP COP	2.6	69
	Control	3.8	41

[1/] Both compounds were broadcast and incorporated at 19 liters product per acre 1 week before planting.

[2/] Disease index on a scale of 0 to 7, with 0 = no disease and 7 = plant dead; means of three replications.

[3/] % harvestable roots calculated by combining disease index classes 0 through 3 and dividing by total roots in a plot; means of three replications.

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The increase in root rot severity with the use of phorate and aldicarb requires careful evaluation. First, we emphasize that these chemicals were tested in an area of uniformly high *Rhizoctonia* population, and in the absence of significant insect problems. Failure to use an appropriate control when economically damaging insect populations are present could result in greater losses from the insects than from a *Rhizoctonia*-insecticide interaction. Conversely, indiscriminate use of the insecticides should be avoided in areas where root rot is prevalent but insects are not a problem.

(This study was partially supported by the Grower-G.W. Joint Research Committee, Inc.)

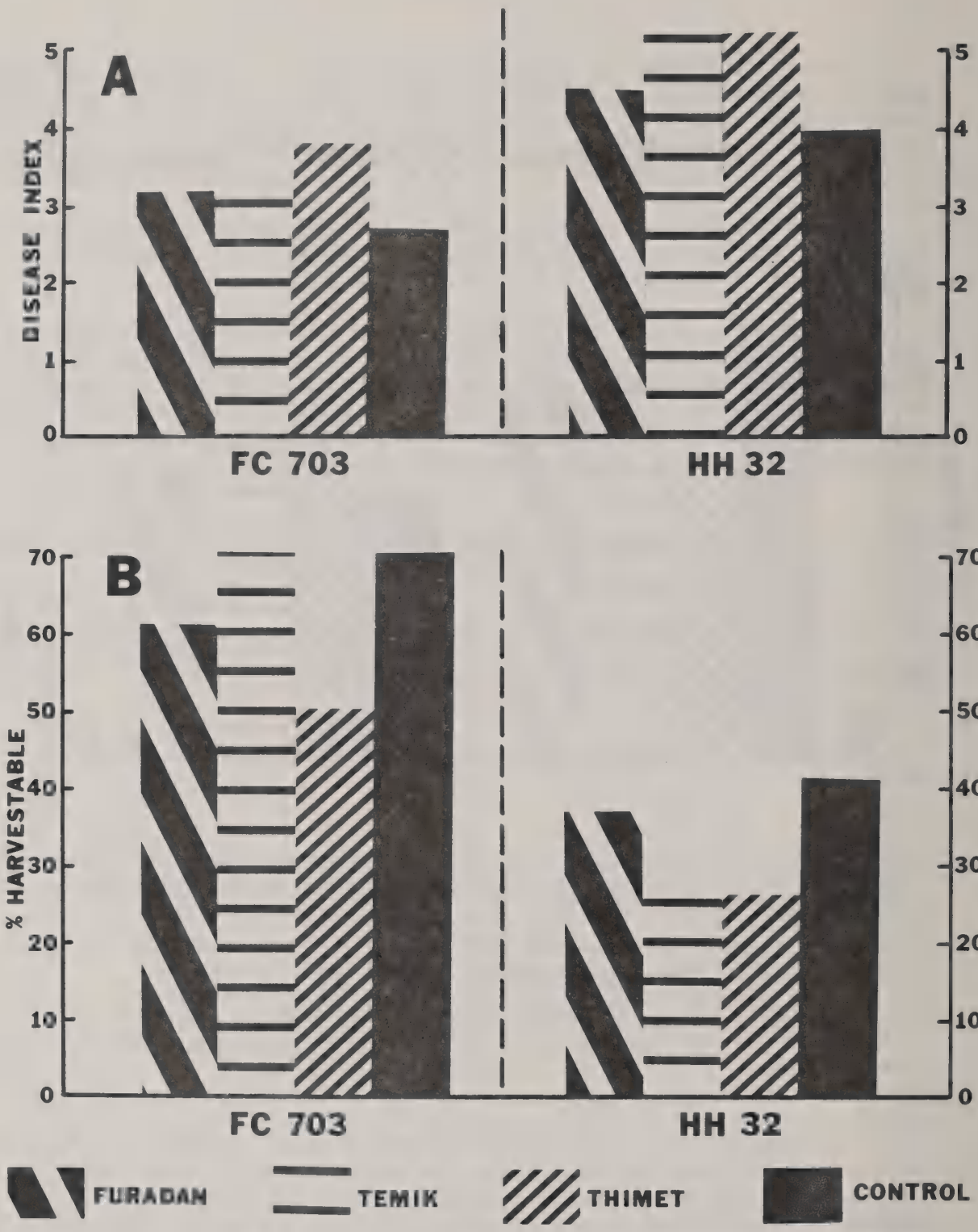

Figure 2. Effect of three systemic insecticides on the development of rhizoctonia root rot in two sugarbeet cultivars in the field. A) Disease index on a scale of 0 to 7, with 0 = no rot and 7 = plants dead. B) % harvestable roots derived by combining disease index classes 0, 1, 2, and 3. (Means of six replications.)

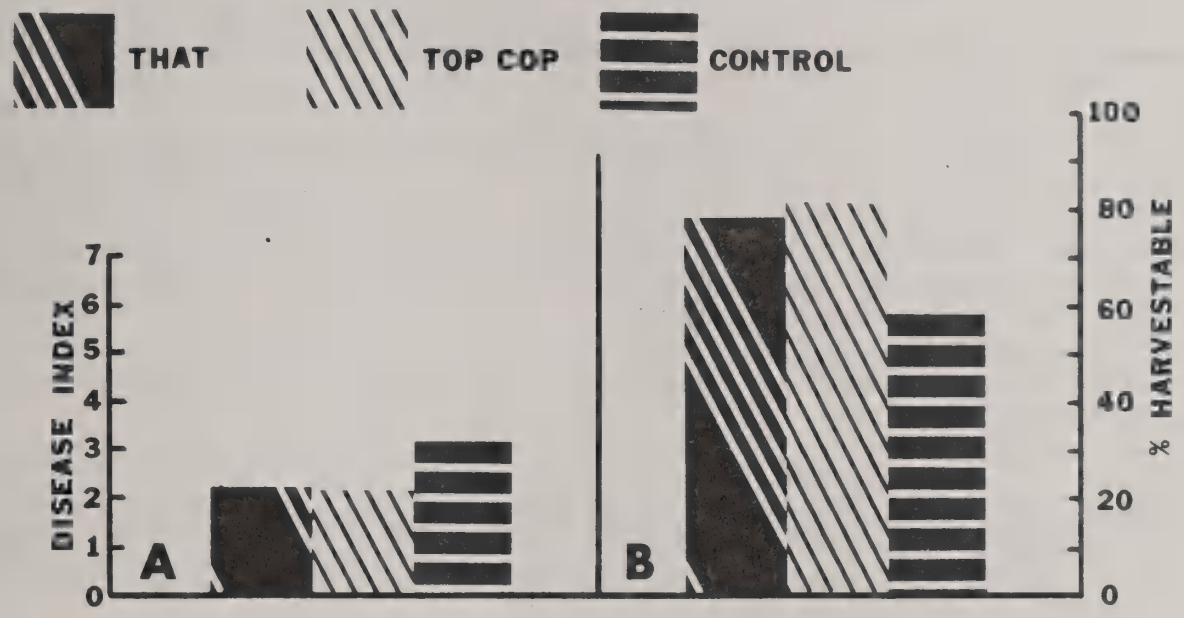

Figure 3. Effect of preplant incorporated flowable sulfurs at 50 gal/acre on the severity of rhizoctonia root rot across two sugarbeet cultivars. A) Disease index on a scale of 0 to 7, with 0 = no rot and 7 = plants dead. B) % harvestable roots derived by combining disease index classes 0, 1, 2, and 3. Bars within each graph topped with the same letter are not significantly different at $P = 0.05$ according to Duncan's multiple range test.

Effect of Two Preplant Herbicides on Disease Intensity of Rhizoctonia Root Rot in the Field.--E. G. Ruppel and R. J. Hecker.

A randomized complete block design with four replications was used in an area of our nursery known to be heavily infested with *Rhizoctonia solani* for a test on the effect of preplant ethofumesate (2 lb a.i./acre) and diclofop methyl (1½ lb a.i./acre) on rhizoctonia root rot severity in commercial cultivar Mono Hy D2. Four-row plots were 3.7 meters long with 56 cm between rows; only the center two rows were harvested and evaluated.

Neither herbicide, alone or in combination, had any significant effect on the incidence or severity of root rot. Mean disease indices (DI) for ethofumesate, diclofop methyl, and the combination were 3.4, 3.8, and 3.4, respectively. The DI for the nontreated control was 3.8. Percentage harvestable roots were 50, 44, and 50% for the herbicide treatments, respectively, whereas the control was 47%.

(This study was partially supported by the Grower-G.W. Joint Research Committee, Inc.)

Effect of Antagonistic Fungi on Rhizoctonia Damping-off and Root Rot in Sugarbeet Field Plots.--E. G. Ruppel, R. Baker, I. Chet, G. Harmon, and R. J. Hecker (cooperative study with the Botany & Plant Pathology Department, Colorado State University).

A randomized complete block design with four replications was used to test two known fungal antagonists of *Rhizoctonia solani* for the control of rhizoctonia damping-off and root rot in the field. An area of our field nursery known to be heavily invested with *R. solani* was chosen for this study. Four-row plots were 3.7 meters long with 56 cm between rows. Commercial cultivar Mono Hy A1 was used throughout. The field was planted on May 5, and thinned to a spacing of 25 cm between plants on about June 5. Stand counts of all rows were made on May 26, June 23, July 15, and August 5. On September 18, the center two rows of each plot were harvested, and the roots were rated for degree of rot on a scale of 0 to 7, with 0 = no rot and 7 = plant dead. An average disease index, % healthy roots, and % harvestable roots were calculated for each plot. Treatments included seed treatment with *Trichoderma hamatum*, seed treatment with *T. hamatum* pelleted with chitin, seed treatment with *Laetisaria arvalis* (formerly *Corticium* sp.), a preplant in-furrow treatment with *T. hamatum* on clay granules, seed treatment with manzate fungicide, and a nontreated control. The in-furrow treatment applied about 10^6 propagules of *Trichoderma* per gram of soil in a 10-cm band over the row with incorporation to a depth of 10 cm. Seed treatments with antagonists, and the preparation of *Trichoderma*-infested clay granules were done by Abbott Laboratories, Long Grove, IL.

Table 1 presents the results of stand counts expressed as a percentage of nontreated control. Analyses of stand count data indicated that differences among treatments were only significant at the first count, before thinning. At this time, stands in the treatments with *Trichoderma* and the manzate treatment were not significantly different from the control. The stand in the *Laetisaria* treatment was significantly lower than that in all treatments except in-furrow *Trichoderma*.

Table 1. Effect of antagonistic fungi on stands of sugarbeet planted in soil heavily infested with *Rhizoctonia solani*.

Treatment	Mean % of control stands			
	5/26	6/23	7/15	8/5
Trichoderma on seed	114.6	96.8	99.5	104.7
Trichoderma/chitin on seed	114.5	91.5	98.6	97.4
Laetisaria on seed	77.3	96.0	100.0	101.6
Trichoderma in-furrow	92.3	96.0	101.8	107.8
Manzate on seed	114.6	96.8	104.6	112.4
(F-test for treatments)	*	NS	NS	NS

Mature root rot severity at harvest is presented in Table 2. Only the manzate treatment significantly reduced the disease index as compared with the control, and this treatment was not significantly different than the *Trichoderma* seed treatment or the in-furrow *Trichoderma* treatment.

Table 2. Effect of antagonistic fungi on mature root rot of sugarbeet grown in soil heavily infested with *Rhizoctonia solani*.

Treatment	D.I.[1]	% healthy[2]	% harvestable[3]
Trichoderma on seed	3.0 ab	46.3	57.1
Trichoderma/chitin on seed	3.3 a	41.3	52.9
Laetisaria on seed	3.8 a	35.3	48.6
Trichoderma in-furrow	2.8 ab	55.7	65.6
Manzate on seed	2.1 b	61.7	71.7
Nontreated control	3.4 a	39.9	50.7
F-test	*	NS	NS
C.V. (%)	20.8	16.7	15.3

[1]D.I. (Disease index) based on a scale of 0 to 7, with 0 = no rot and 7 = plants dead.

[2]D.I. classes 0 and 1 (small, arrested, scurfy lesions) were combined to calculate percentage healthy beets.

[3]D.I. classes 0 through 3 were combined to calculate percentage harvestable beets; beets in these classes would be included in factory processing operations.

CERCOSPORA/CURLY TOP RESISTANCE BREEDING AND RELATED RESEARCH

(BSDF Project 25)

Breeding for Resistance to Cercospora and Curly Top Virus. 1980.--G. A. Smith and E. G. Ruppel.

The leaf spot epidemic in our 1980 nursery provided adequate but not excellent conditions for evaluation of breeding lines. The average resistant check rating in 1980 was 3.0. The average rating of our leaf spot resistant check in 1977, 1978, and 1979 was 4.6, 3.0 and 3.8, respectively. The curly top epidemic at Logan, Utah was considered moderate, with US 41 averaging 4.1 as compared with 3.2 in 1979. Under the severity of the 1980 epidemic, a leaf spot rating of 3.0 would be considered good. The results from our breeding nursery tests for the 1980 leaf spot and curly top epidemics are presented in Table 1.

Table 1. Mean leaf spot and curly top ratings of some breeding lines tested at Fort Collins, CO and Logan, UT, 1980.

Entry No.	Seed No.	Description	Leaf spot[1]	Curly top[1]
1266	791013H03	FC 502/3 CMS X FC 605 T.O., mm	2.3	4.0
1267	791013H04	662119s1 CMS X FC 605 T.O., mm	2.8	2.5
1268	791013H05	FC 603 CMS X FC 605 T.O., mm	2.3	3.5
1269	791013H06	642027s1 CMS X FC 605 T.O., mm	2.0	4.0
1270	791013H07	1861 CMS X FC 605 T.O., mm	3.3	3.0
1271	791013H08	(642027s1 CMS X 662119s1 T.O.) X FC 605 T.O. mm	2.5	4.0
1272	791013H09	632028s1 CMS X FC 605 T.O., mm	3.3	3.5
1273	791013H010	622112s1 CMS X FC 605 T.O., mm	2.8	3.5
1274	791015H02	FC 605 CMS X FC 502/2 T.O.	3.0	4.5
1275	791015H03	FC 606 CMS X FC 502/2 T.O.	2.5	4.5
1276	791015H04	(652016s1 CMS X FC 605) X FC 502/2 T.O.	3.0	4.5
1277	791015H05	(652016s1 CMS X 662119s1 T.O.) X FC 502/2 T.O.	3.5	4.0
1278	791016H02	FC 605 CMS X FC 502/3 T.O.	2.0	3.5
1279	791016H03	FC 606 CMS X FC 502/3 T.O.	3.3	4.5
1280	791016H04	(652016s1 CMS X 662119s1 T.O.) X FC 502/3 T.O.	3.3	4.0
1281	791016H05	632028s1 CMS X FC 502/3 T.O.	3.3	5.0
	791017H02	L53 CMS X 662119s1 T.O.		3.0
1287	791017H03	652016s1 CMS X 662119s1 T.O.	3.0	2.3
1288	791017H04	FC 502/2 CMS X 662119s1 T.O.	3.8	3.5
1289	791017H05	FC 606 CMS X 662119s1 T.O.	3.0	1.5
1290	791017H06	[FC(504 X 502/2) CMS X FC 605 T.O.] X 662119s1 T.O.	3.3	3.0
1291	791017H07	(652016s1 CMS X FC 605 T.O.) X 662119s1 T.O.	3.0	2.0
1292	791017H08	1861 CMS X 662119s1 T.O.	4.0	2.0
1293	791017H09	622112s1 CMS X 662119s1 T.O.	3.5	3.5

(Continued)--

Table 1. Mean leaf spot and curly top ratings. . . --Continued

Entry No.	Seed No.	Description	Leaf spot[1]	Curly top[1]
1294	791018H01	L53 CMS M_ X L53 T.O. M_	7.0	5.0
1295	791013H02	FC 605 CMS X L53 T.O. M_	3.8	3.0
1296	791013H03	(642027s1 X 662119s1 T.O.) X L53 T.O. M_	6.8	3.0
1297	791013H04	FC 606 CMS X L53 T.O. M_	5.3	2.5
1298	791019H02	L53 CMS M_ X 661153HO; 642027s1 = FC 603 T.O.	5.0	3.5
1299	791019H03	FC 605 CMS X 661153HO; 642027s1 = FC 603 T.O.	2.8	3.0
1300	791019H04	FC 502/2 CMS X 661153HO; 642027s1 = FC 603 T.O.	2.8	6.0
1301	791019H05	FC 606 CMS X 661153HO; 642027s1 = FC 603 T.O.	2.8	3.5
1302	791019H06	(652016s1 CMS X FC 605) X 661153HO; 642027s1 = FC 603 T.O.	3.0	4.0
1303	791019H07	622027s1 CMS X 661153HO; 642027s1= FC 603 T.O.	3.5	4.0
1304	791021H02	L53 CMS M_ X FC 606 T.O.	4.3	3.5
1305	791021H03	1861 CMS X FC 606 T.O.	3.3	2.0
1306	791021H04	632028s1 CMS X FC 606 T.O.	3.5	2.5
1307	791021H06	(1861 CMS X 12166) X FC 606 T.O.	3.5	1.5
1309	791022H04	662119s1 CMS X 1861 T.O. mm	4.0	2.5
1310	791022H05	FC 606 CMS X 1861 T.O. mm	3.5	3.0
1311	791022H06	[FC(504 X 502/2) CMS X FC 605] X 1861 T.O. mm	4.0	3.5
1312	791022H07	(652016s1 CMS X FC 605) X 1861 T.O. mm	3.3	3.0
1313	791022H08	(642027s1 CMS X 662119s1 T.O.) X 1861 T.O. mm	5.0	2.5
1314	791022H09	(652016s1 CMS X 662119s1 T.O.) X 1861 T.O. mm	4.5	1.5
1315	791022H010	622112 s1 CMS X 1861 T.O. mm	3.8	1.5
1319	791023H01	632028s1 CMS X 632028s1; 651151 HOA,B; 661151 HOA	3.3	3.0
1320	791023H02	FC 606 CMS X 632028s1; 651151 HOA,B; 661151 HOA	2.5	2.5
1321	791023H03	[FC (504 X 502/2) CMSX FC605]X632028s1; 651151HOA,B; 661151HOA	3.3	4.0
1322	791023H04	1861 CMS X 632028s1; 651151 HOA,B; 661151HOA	4.5	2.5
1325	791024H03	FC 606 CMS X 622027s1; 642010s1 T.O.	3.0	4.0
1327	791025H03	FC 606 CMS X 622112s1, 642063 T.O.	3.5	2.5
1328	791025H04	[FC(504 X 502/2) CMS X FC 605] X 622112s1, 642063 T.O.	3.0	3.5
1329	791026H02	FC 606 CMS X SP 550	2.8	5.5
1339	791057H10	FC 607 CMS X EL43	3.5	5.0
1345	771046H03	FC 506 CMS X L36	4.8	3.0
1348	791069H9	(FC 506 CMS X L36) X Syn from SP5831-0	3.8	4.0
1349	791069H10	(652016s1 CMS X 662119s1) X Syn from SP5831-0	4.0	4.5
	A79-67	FC 607 T.O.		5.0

(Continued)--

Table 1. Mean leaf spot and curly top ratings . . .--Continued

Entry No.	Seed No.	Description	Leaf spot[1]	Curly top[1]
1355	761039HO2	FC 607 CMS X SP 6322-0	2.5	4.0
1356	761036HO3	FC 602 CMS X 761036HO	3.0	3.5
1357	761036HO5	FC 605 CMS X 761036HO	2.8	3.0
1358	751102HO1	FC 605 CMS	3.3	3.5
1359	751102HO5	FC 506 CMS X FC 605 T.O.	2.5	3.5
1360	781051HO4	FC 605 CMS X 1861 T.O.	3.8	3.0
	A78-44	FC 606 T.O.		3.0
	781005HO	FC 608 T.O.		4.0
	751102HO3	FC 608 CMS		3.0
	A79-31	HH 26		5.0
1411	A79-68	FC 607 CMS	2.3	4.0
1412	A78-45	FC 606 CMS	2.5	3.0
1413	A78-1	GW Mono Hy D2	3.8	6.5
	Checks			
1286	LSS check, synthetic check		6.5	
1415	671201HO8	[FC (504 X 502/2) X SP 6322-0; LSR check]	3.0	5.5
	US 41	Logan check		4.1
	US 33	Logan check		5.0

[1]Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = dead for curly top or complete defoliation for leaf spot.

FC 606 (entry 1412) and FC 607 (entry 1411) continued to show good levels of combined leaf spot/curly top resistance, with 606 superior for curly top resistance and 607 superior for leaf spot resistance. Among the newer lines showing superior resistance levels to both diseases were entry numbers 1278, 1320, and 1357. If these lines continue to show these levels of resistance under more severe epidemics, they may be developed further for release. Several lines demonstrated superior resistance to curly top with moderate resistance to leaf spot. Entry number 1289 was especially noteworthy in that its level of resistance to curly top was very high, and one-half of its parentage is FC 606. Several crosses using 1861 T.O. as the pollen parent gave very good levels of resistance to curly top (entries 1309 through 1315). As in 1979, FC 607 CMS X SP 6322-0 showed good resistance to leaf spot and was again very vigorous. Under the more severe leaf spot epidemic of 1979, this cross displayed the highest resistance of any entry in the nursery.

Lines which show consistently high levels of disease resistance in our cercospora nursery are frequently evaluated in hybrid combination under nondisease conditions. Evaluations of the most recently released lines FC 606 and FC 607 are being made in such tests. Table 2 presents some of the results from 1980 under non-disease conditions. The test site located at the CSU agronomy farm was high in soil nitrogen as is reflected by the

relatively low sucrose percentages. Eight of the 23 experimental crosses with FC 606 or FC 607 produced over 7000 pounds per acre of gross sucrose. Entry number 1051, FC 606 CMS X L53 T.O., was the highest yielding cross in the test, outyielding the GW Monohy D2 check. This entry also had a high level of curly top resistance in the 1980 Logan nursery (see entry number 1297 of Table 1). Crosses of FC 607 CMS with *Rhizoctonia*-resistant pollinators resulted in several high yielding crosses. Entry numbers 1063 and 1067 yielded 7596 and 7421 pounds of sucrose per acre, respectively. Entry 1063 was a triploid hybrid, since the *Rhizoctonia*-resistant pollinator was FC 702/4(4X).

Table 2. Summary of yield results for experimental hybrids with FC 606 and FC 607 parentage.

Entry	Seed no.	Variety and/or description	% Sucrose	Gross sucrose lbs/A
1048	791017H05	FC 606 CMS X 662119s1 T.O.	12.47	6211 ef[1]
1049	791017H06	FC 607 CMS X 662119s1 T.O.	12.36	6960 abcde
1050	791017H07	(652016s1 CMS X FC 605 T.O. 662119s1 T.O.	12.66	6511 def
1051	791018H04	FC 606 CMS X L53 T.O.	14.25	7908 a
1052	791019H05	FC 606 CMS X FC 603 T.O.	13.24	6236 ef
1053	791021H06	(1861 CMS X 12166) X FC 603 T.O.	14.05	6660 bcdef
1054	791022H05	FC 606 CMS X 1861 T.O. mm	14.25	7084 abcde
1055	791022H06	FC 607 CMS X 1861 T.O. mm	14.63	6660 bcdef
1056	791023H02	FC 606 CMS X 632028s1	14.24	4665 g
1057	791023H03	FC 607 CMS X 632028s1	15.28	6249 ef
1058	791025H03	FC 606 CMS X 622112s1, 642063 T.O.	14.13	6299 ef
1059	791025H04	FC 607 CMS X 622112s1, 642063 T.O.	14.65	5800 f
1060	791026H02	FC 606 CMS X SP 550	15.40	6436 def
1061	791028H2	FC 606 CMS X FC 904 mm	12.90	6960 abcde
1062	791028H3	FC 607 CMS X FC 904 mm	13.63	7097 abcde
1063	791055H6	FC 607 CMS X FC 702/4(4X)	14.40	7596 abc
1064	791057H10	FC 607 CMS X EL 43	12.79	6585 cdef
1065	791060H3	FC 607 CMS X 67-436 (4X) mm, high suc.	16.59	7059 abcde
1066	791064H7	FC 607 CMS X Syn from FC 701 X (LSR-CTR, mm, T.O.)	14.07	6723 bcdef
1067	791070H13	FC 607 CMS X Syn from FC 703	14.21	7421 abc
1068	791071H9	FC 607 CMS X Syn from FC 702/5	14.17	7047 abcde
1069	791122H6	FC 607 CMS X 5th cy. low Amino N. sel. at high N fertility	13.43	7159 abcde
1070	791053H12	FC 607 CMS X FC 705	13.11	7134 abcde
1071	A78-1	GW Mono Hy D2	13.59	7633 ab

[1]Means followed by the same letter are not significantly different at the .05 probability level. C.V. = 7.9% for gross sucrose.

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.--
E. G. Ruppel and G. A. Smith.

Separate randomized complete block designs with two to four replications were used to evaluate a total of 153 breeding lines submitted by the following sugar and seed companies: American Crystal, Great Western, Holly, Beta Seed, and Bush Johnson for their response to infection with *Cercospora beticola*. Internal check lines included leaf spot resistant FC (504 X 502/2) X SP 6322-0, a susceptible synthetic, and, in some tests, SP 5822-0 having intermediate resistance to *Cercospora*. The nursery was planted May 7, and inoculated June 8 and again on June 17. The epiphytotic developed quite rapidly at first, but then leveled off in August and finally peaked in early September. Leaf spot ratings were made on August 26, September 2, and September 5 on our usual 0 to 10 scale. On September 5, mean ratings for the resistant check ranged from 2.8 to 3.3 (mean = 3.0) across tests, whereas the susceptible check ranged from 6.8 to 7.0 (mean = 6.9). The intermediate check ranged from 3.0 to 3.3 (mean = 3.2). Company lines ranged from 2.8 to 7.8 on this date. Results of the individual tests were tabulated, statistically analyzed, and sent to each respective contributor.

SUGARBEET QUALITY IMPROVEMENT (BSDF Project 53)

Impurity Component Comparison of a Half Fodder Beet and a Sugarbeet.--
S. S. Martin, R. J. Hecker, and G. A. Smith.

We have made a preliminary comparison of several chemical components in a half fodder beet (HFB: 52-305 CMS X Ovana, F_1) and in a sugarbeet (Mono Hy D2). These data were obtained in a larger experiment which was conducted in a randomized complete block design with two nitrogen levels and 18 replications. The entire experiment received preplant ammonium nitrate at 118 kg N/ha ("regular N"); the "high N" treatment received an additional 112 kg N/ha, as ammonium nitrate side-dressed at 10 weeks after planting. The experimental area had about 112 kg N/ha as residual nitrate in the top 60 cm of soil. Each plot consisted of four rows, each 6.4 m long. Each of the two center rows of a plot was harvested separately and the roots were composited as a single sample.

Under regular N levels, sucrose content (as percentage of root fresh weight) of HFB averaged 77% of that of the commercial sugarbeet variety (Table 1). Sodium, potassium, and amino N were present in the HFB at levels averaging 2.8X, 1.9X, and 1.7X, respectively, the comparable quantities (in g/100 g sucrose) in the sugarbeet. Under excessive nitrogen fertilization, sucrose decreased more in HFB than in sugarbeet, whereas sodium, potassium, and amino N increased more in HFB than in sugarbeet. These changes are reflected in the increased ratios (HFB/D2 in Table 1) found for sodium, potassium, and amino N, and the decreased ratio for the sucrose comparison. The differences observed between the data for "regular N" and "high N" treatments were less than might have been expected, undoubtedly because residual soil nitrogen was quite high.

Table 1. Comparison of half fodder beet and sugarbeet.[1]

Component[2]	Regular N			High N		
	HFB	MonoHy D2	Ratio HFB/D2	HFB	MonoHy D2	Ratio HFB/D2
Sucrose (% FW)	11.95	15.53	0.77	11.21	15.29	0.73
Sodium	0.89	0.32	2.8	1.13	0.35	3.2
Potassium	1.91	0.99	1.9	2.05	1.05	2.0
Amino N	0.48	0.28	1.7	0.54	0.30	1.8
Sucrose (MT/ha)	8.74	9.69	0.90	8.44	9.69	0.87

[1]Half fodder beet (HFB) = 52-305 CMS X Ovana, F_1; Sugarbeet = Mono Hy D2.
[2]Sucrose as % of root fresh weight; sodium, potassium, and amino N as g/100 g sucrose. Gross sucrose in MT/ha. n=36.

Parent-hybrid Relationship for Root and Crown Production, and Components of Quality and Sucrose Yield.-- R. J. Hecker, I. Romagosa, S. S. Martin and G. A. Smith.

An attractive alternative to the standard harvesting procedure in sugarbeets is to remove only the leaves and petioles instead of removing the whole crown. A 2-year field experiment has been conducted at Fort Collins to determine whether the root-crown relationship of the parents is a necessary consideration in making productive hybrids, and to determine the relation of parents and hybrids in producing productive, high quality, hybrids which could be flailed rather than topped.

A complete analysis of the experiments must await the 1980 quality data, which are still being collected. However, a preliminary multivariate analysis was done on the 1979 data. This analysis of root weight, sucrose, thin juice purity, and of sodium, potassium, and amino nitrogen in raw juice from both root and crown tissue indicates that there are more significant differences and effects on sucrose yield and purity for root than for crown measurements. Hence, more can be inferred from parents about root sucrose yield and purity than about these characters in crown tissue. Multivariate tests show that sets of contrasts account for more variability and have greater levels of significance than univariate contrasts. From canonical correlations, the first canonical variable from the root coefficients explained most (82%) of the crown character variances. Heritabilities (h^2) from regression of hybrids on male and female parents and midparents were low and inconsistent for most root and crown characters. This h^2's preliminarily indicates relatively small contributions of additive genetic variance, a likely occurrence in the case of root and sucrose yield, but not in the case of sucrose content or the raw juice chemical characters.

To facilitate visualizing a multivariate assessment of parents and hybrids, a principal component analysis was used to restructure the variables into two principal components. Two dimensional plots of female and male parents and their hybrids showed a clear separation of parental lines, with the hybrids, for the most part, lying between their parents.

From these preliminary analyses, there appears some promise that hybrids suitable for flail harvesting from the standpoint of quality and sucrose yield, might be predictable from some standardized multivariate analysis of parental assessments. A complete analysis and report on these experiments will be made next year.

Selection and Breeding Studies for High and Low Amino N and for Post-harvest Quality Improvement.-- R. J. Hecker, S. S. Martin, and G. A. Smith.

Two separate quality research and germplasm improvement projects were in the field selection phase in 1980. In 1980, the first project, selection, and breeding for high and low amino nitrogen (N), was in the sixth and fourth cycles of selection, respectively. From about 1500 roots, 430 and 368 agronomically acceptable roots of the high and low amino N populations were selected, from which about 50 roots will be selected for high and for low amino N. This will be about 3.3% of each initiate population. Although not a replicated arrangement, the selection strips were comparable; hence, a comparison of the two populations is of interest. After five cycles of selection for low amino N in sucrose filtrate, the mean root weight and sucrose of 430 agronomically selected roots were 1.12±.02 kg and 14.8±.1%, respectively. After three cycles of high amino N selection, the respective values for 368 roots were 1.22±.03 kg and 11.5±.1%. Hence, it appears that selection for high amino N has caused a reduction in sucrose content but only a small increase in root weight. The two populations appeared outwardly the same. In 1981 the fourth and sixth cycle selections will be interpollinated within groups and crossed to a set of CMS combining ability (CA) testers. In 1982, a complete field assessment will be made of each cycle of selection, source population, and CA testers. Potentially useful germplasm will then be released, and genetic interpretations and breeding implications will be made.

The second project, selection and breeding for improved post-storage (±100 days) quality at optimum and excess N fertility, was in the third cycle of selection in 1980. From about 1300 roots, 455 and 462 agronomically acceptable roots were selected from the optimum and excess N treated populations, respectively. About 50 roots will be selected for high purity index from each of these sources. Unfortunately, in 1980 the optimum N treatment was obviously excess N due to location in an area of very high residual N, undetected by our routine soil tests. As a consequence of actual excess N on both areas, the root weight and sucrose % of the 455 and 462 selected roots were little different, 0.97±.02 kg and 11.0±.1% for the "optimum N" selections, and 0.89±.02 kg and 11.1±.1% for the "excess N" selections. This will not seriously compromise the experiment, unless there is a great interaction between the purity index and N fertility. In 1981 the ±50 selected roots of each population will be respectively interpollinated and crossed to a set of CA testers. In 1982, a field assessment will be made

of selections, source population, and CA test-hybrids to determine selection progress and decide on continuation of the project.

RESEARCH NOT FUNDED BY BSDF BUT OF INTEREST TO BSDF MEMBERS

International Cooperative Cercospora Resistance Evaluation Test.-- G. A. Smith and Bengt-Olle Jonsson.

The potential of strain differences in *Cercospora beticola* has frequently been debated. The possible occurrence of European and American strains differing in pathogenecity appeared to be a quite logical hypothesis.

In 1980, arrangements were made to test several European-developed breeding lines with several American-developed breeding lines under natural epidemic conditions in southern Europe. Of particular interest was the evaluation of FC 607 which is the most recently released cercospora resistant line developed at Fort Collins. All of the cercospora resistant lines released from the Fort Collins breeding program are developed under artificially induced field epidemics.

Replicated field tests consisting of 5 entries from Fort Collins and 6 entries submitted by Hilleshog were conducted under natural field epidemics in Greece (Platy-Imathios), Stelata, Italy (Po Valley), and Valladolid, Spain (Duero River Valley). The same entries were tested under our standard artificial field inoculation at Fort Collins. Epidemics were quite severe and uniform in Italy, severe but late in Greece, and mild in Spain. The epidemic at Fort Collins was considered moderate as compared to previous years. An old multigerm Italian variety "Alba" was used as the resistant check in Greece, Italy, and Spain. This variety, although very leaf spot resistant, is not grown commercially and is strictly a check. FCLRC is the long term cercospora resistant check at Fort Collins and was included in the tests at all locations. FC 607, FC 606, and a new experimental line FCL 3 displayed high leaf spot resistance at all locations. FC 607 was essentially equal to Alba at all locations and better than all other entries overall. A summary of the results are presented in Table 1.

Although this study does not preclude the existence of strain differences for pathogenicity in cercospora, it does not point to such differences either. The test will be repeated in the same countries in 1981.

Table 1. Summary of leaf spot ratings from international cooperative cercospora resistance evaluation test.

Entry	United States	Greece	Italy	Spain	Average across countries
FCL 1, FC 607 CMS	2.8[1]	1.5	1.4	1.0	1.7
FCL 2, FC 606 CMS	3.0	1.6	2.3	1.0	2.0
FCL 3, FC 605 CMS x 731021 HO, T.O.	3.0	2.6	1.6	1.5	2.2
FC ILC, SP 5822-0	3.2	1.6	1.9	1.3	2.0
FC LRC, FC(504 x 502/2) x SP 6322-0	2.9	1.3	1.8	1.4	1.9
Hh Mono CR-1	3.3	2.1	2.0	1.0	2.1
Hh Mono CR-2	4.6	3.1	2.9	1.4	3.0
Hh Mono CR-3	4.9	4.0	3.1	1.5	3.4
Hh Mono CR-4	6.4	5.1	4.6	1.9	4.5
Hh Mono CR-5	6.8	5.1	4.3	1.5	4.4
Hh Mono CR-6	6.3	5.1	3.6	1.9	4.2
Alba P, ck.	-	1.3	1.6	1.0	1.3

[1]Average leaf spot rating based on 0-10 visual scale where 0 = no infection, and 10 = complete defoliation.

The Evaluation of Fodder Beet as a Source of Ethanol.--G. A. Smith.

In 1980 we began an evaluation of fodder beet and sweet sorghum as potential feedstocks for ethanol production. This project, made possible by short-term funding, is designed to establish the agronomic yield capabilities of these crops as they relate to potential biomass or ethanol production.

Uniform variety tests for the 14 fodder beet entries listed in Table 1 were conducted at Fort Collins and five additional locations in 1980. Similar uniform tests are planned for 1981. All of the entries except the known checks were developed in Europe. Although the pedigree of these entries is not known, the high dry matter and sucrose percentages indicate that most are sugarbeet X fodder beet hybrids with a considerable amount of introgression of sugarbeet germplasm.

Table 1. Summary of means for 14 fodder beet or sugarbeet X fodder beet hybrids and two sugarbeet checks.

Entry	Description	Root yield T/A	Sucrose %	Gross sugar lb/A	% dry wt. of roots	Theoretical[1] Ethanol g/A
965	GW D2, check (2X)	22.9	17.60	8070	26.2	538 ab
966	Zwanpoly, check	26.4	15.92	8409	24.0	561 a
951	Lamono 1 (2X)	29.1	12.54	7286	20.1	486 bcd
952	Lamono II (2X)	30.4	11.41	6941	19.1	463 cd
953	Monorosa (2X)	28.9	13.00	7519	20.1	501 abcd
954	Yellow Daeno (2X)	29.4	10.06	5907	17.6	394 e
955	Monoblanc (3X)	30.8	11.95	7364	19.5	491 bcd
956	Kyros (3X)	35.8	11.13	7962	18.3	531 ab
957	Monara (3X)	33.1	9.03	5974	16.8	398 e
958	Monriac (3X)	31.3	11.67	7303	19.2	487 bcd
959	Eckdobarres (69% 4X, 31% 3X)	31.7	8.79	5572	16.6	371 e
960	Oscar (81% 4X, 19% 3X)	35.0	9.63	6748	17.2	450 d
961	Beta Rose Sugar (44% 4X, 56% 3X)	33.8	10.85	7325	18.6	488 bcd
962	Barsien (78-2) (62% 3X, 38% 2X)	28.3	12.65	7149	20.3	477 bcd
963	Monovigor (3X)	34.5	11.35	7838	18.8	523 abc
964	Monorosover (3X)	32.0	11.79	7549	19.7	503 abcd

[1]Means within a row followed by the same letter are not significantly different at the .05 probability level.

Several of the "fodder beet" entries yielded over 7300 lbs gross sucrose, which approached the sugarbeet checks (Table 1). Four entries (953, 956, 963 and 964) gave gross sucrose yields not significantly different from the Zwanpoly check. The root yields of these four entries were 2.5 to 9.4 tons greater than Zwanpoly.

Sweet Sorghum Ethanol Yield Potential.-- G. A. Smith.

An evaluation of sweet sorghum (*Sorghum bicolor*) as a potential feed stock for ethanol production was begun in 1980 as part of a USDA energy study.

Sweet sorghum cultivars were evaluated for yield potential at seven locations in the U.S. Cooperators in this project were R. T. Lewellen, I. O. Skoyen, G. E. Coe, G. J. Hogaboam, K. Freeman, D. L. Doney and F. J. Hills. Data collected included, total biomass yield, total sugar, types of sugars, dry matter, height, stalk diameter, and percent leaves and stalks.

The initial results from the first year's study indicated that sweet sorghum has potentially very wide adaptability to varying environments. Sweet sorghum's obvious potential for wide adaptability is accompanied by favorable agronomic characteristics, such as easy planting and cultivation, high fiber content (for potential use in paper production or as a combustible fuel source), and relatively few major disease problems. The prominent disadvantage is storability of harvested stalks.

Summarized yield data and theoretical ethanol production are summarized in Table 1.

Table 1. Summary of net stalks yield (T/A) and theoretical ethanol yield (g/A) from uniform variety tests conducted at seven locations in 1980.

	Net stalk yield				Potential ethanol			
Location	Dale	Keller	Rio	Wray	Dale	Keller	Rio	Wray
Brawley		30.3	27.1	23.9		685	498	519
Davis	42.3	43.8	34.1	50.0	845	877	683	1000
Logan	25.7	26.0	21.9	25.4	342	347	292	338
Ft. Collins	40.2	37.3	33.6	40.9	536	496	448	545
East Lansing	28.0		21.6	30.3	413		333	470
Merridian	21.3		20.7	20.4	374		317	320
Beltsville	21.0	22.5	20.1	21.8	420	466	336	448

It is expected that the techniques for data collection developed in 1980 will enable a further collection of reliable data in 1981, which will give a true evaluation of the agronomic potential for sweet sorghum ethanol production in the United States. A uniform set of cultivars will be evaluated in 1981 at seven locations in the continental U.S. and one location in Hawaii.

Differential Response of Sugarbeet Cultivars to Herbicides.--G. A. Smith and E. E. Schweizer.

Since 1977 we have conducted research designed to detect cultivar X herbicide interactions. The purposes of these studies was to determine the physiological and morphological effects of the herbicide on measurable sugarbeet characters and not to determine the weed control effectiveness of herbicide treatments. The effects of preplant and postemergence herbicide combinations have been studied. In these studies, all herbicides were applied at recommended rates for weed control. The results presented here are short summaries of three experiments conducted over the four-year period of 1977-1981.

Experiment I - In this experiment we studied the effects of Ro-Neet applied preplant followed by a mixture of Betanal plus Betanex (B + B) applied postemergence, and of Nortron applied preplant plus a mixture of B + B postemergence. These herbicide combinations were applied to a diverse set of 15 genotypes consisting of 5 inbred lines, 5 experimental F_1 hybrids, and 5 commercial cultivars. All 15 entries also were grown without herbicide treatment. In all treatments, weeds were removed by hand throughout the season. Data taken included root yield, sucrose, purity, foliar suppression, stand and non-sucrose chemical components. A summary of mean squares from the 2-year combined analyses of variance is presented in Table 1.

Eight of ten characters displayed significant year X cultivar (Y x C) interactions, indicating differential cultivar performance in each year. Other first order interactions were year X herbicide (Y x H) and herbicide X cultivar (H x C) for root weight and foliar suppression, respectively. The significant Y x H interaction for root weight indicates that the three treatment regimes did not affect root yield in the same order in each of the two years of the study.

Analyses of variance of the five commercial cultivars alone also showed significant Y x H interaction for root yield, which indicates that the differential effects of the three treatment regimes over the two years was not limited just to sensitive inbred lines and experimental F_1 hybrids. In this study, no significant Y x C interactions for the yield components, root weight, sucrose, or purity were found for the five commercial cultivars. This apparent yield stability as compared to the inbred lines and F_1 hybrids may be attributable to selection and testing under different environments during their development.

Although commercial cultivars in this study were the least sensitive as a group, sensitivity to the herbicide treatments varied among genotypes within each of the three cultivar groups. From the plant breeder's point of view, consistent Y x H and Y x C interactions, such as found in the study, dictate further laborious and expensive field testing over years before a promising cultivar can be released.

Table 1. Summary of mean squares from the two-year combined analysis of variance for the 10 characters studied for 15 sugarbeet cultivars.

	Source of variance[1]						
	Years (Y)	Herbicides (H)	Cultivars (C)	YxH	YxC	HxC	YxHxC
Root wt.	7895**	31	2622**	693**	105**	13	14
Sucrose	35**	4*	40**	0.66	1.84**	0.31	0.26
Purity	70	16*	88**	0.87	4**	1	1
Na	1957	566	8126**	180	822**	123	126
K	36720**	437	28248**	457	1481**	267	219
Nitrate	242062**	5576	42682**	2532	7250**	777	1216
Betaine	302554**	1991	113362**	687	3495**	1500	1104
Amine N	859	73	1528**	298	60	36	47
Chloride	8028**	153*	4740**	14	297**	36	16
Foliar Suppression	0.41	47876**	9429**	1.80	0.21	259**	1.45

[1]The degrees of freedom associated with F-tests were 1 and 5 for years, 2 and 20 for herbicides and YxH, 14 and 420 for cultivars and YxC, 28 and 420 for HxC and YxHxC.

*,**Significant at the 5 and 1% levels of probability, respectively.

Experiment II - In this study, eight commercial or near commercial cultivars approved for use in the type A growing area of Colorado, Nebraska, and Kansas were evaluated under four herbicide treatment regimes. In addition to the Ro-Neet B + B and Nortron B + B pre- and postemergence treatments described in Experiment I, a mixture of Nortron + Hoelon was applied preplant followed by B + B postemergence treatment. All eight cultivars also were grown without herbicide treatment in this test. The eight commercial varieties from three companies were HH 26, Beta 1237, GW D2, GW AS, GW A3, GW D7, GW A4 and GW A1. Varieties were evaluated for 2 years in a six-replicate test in 4-row plots, 21 feet long. Oven-dry plant weights were taken at 33 and 45 days. Root yield, sucrose % and purity % were taken at harvest.

Results, Pre-harvest data - The response of sugarbeet seedlings to the application of herbicides was apparent at 33 days after planting (prior to B + B). The analysis of variance indicated significant differences for both varieties and herbicides. Seedlings in untreated plots weighed more than those receiving herbicide treatments. Visual observations made at this time corresponded to the analysis. The herbicide treated

seedlings were noticeably chlorotic and slightly stunted, while those in the handweeded plots appeared healthy. After 33 days, Mono Hy A4 and Mono Hy D7 were the best performing varieties in the untreated plots and were consistently better able to resist the effects of the three herbicides. No differences among varieties were found under the Nortron regime, and only minor differences among varieties occurred when treated with Ro-Neet or a mixture of Nortron and Hoelon.

Visual observations made immediately before sampling at the 45-day (after B + B) stage of growth revealed extreme variation in varietal response. The chlorotic appearance of all eight varieties receiving herbicide treatment was more pronounced and was reflected in the seedling weights. A significant variety x herbicide interaction was present for 45-day plant weight. The interaction indicates that the varieties did not all respond similarly to each herbicide regime. The data in Table 2 reveal the differences in varietal performance at 45 days over all treatments. Mono Hy A4 produced significantly heavier seedlings than all other varieties in the handweeded control. No significant differences in varietal performance were evident within the Nortron plus B + B treatment.

Variety x herbicide interaction was evident for 45-day plant weight under the Nortron-Hoelon plus B + B treatment. Under this regime, several shifts in varietal ranking were noted (Table 2). These shifts in varietal rankings among different herbicide regimes may indicate that each variety differs in the ability to detoxify certain herbicides quickly.

Results, Harvest data - All eight varieties overcame the effects of the herbicide treatments (although at different rates) as the growing season progressed. The chlorotic condition disappeared and overall vigor returned as the herbicides were detoxified or otherwise inactivated. No visual differences in varietal performance could be seen at harvest between the untreated and herbicide treated plots. The average yields of the eight varieties were about 6% less than untreated checks. The analyses of variance for sucrose % and root weight showed significance among herbicide treatments only for root weight, and among varieties for sucrose % and root weight. A significant variety x herbicide interaction for root weight was found. No such interaction was detected for sucrose %. For root weight, HH 26 performed poorly in the untreated plots as well as when treated with Nortron plus B + B or Ro-Neet plus B + B; however, HH 26 performed as well as six other varieties when treated with a mixture of Nortron plus Hoelon. A more dramatic example of variety x herbicide interaction was seen in the yield performance of Mono Hy A1. When this variety was treated with Nortron plus B + B, the yield was lower than all other varieties tested. When treated with Ro-Neet or Nortron plus Hoelon, the performance of Mony Hy A1 was comparable to the other varieties. This response should not be considered stimulatory but simply reflects the adverse effects of Nortron on Mono Hy A1. Beta 1237 and Mono Hy AS were consistently the highest sucrose varieties across treatments.

Table 2. Differential response of 45-day seedlings to herbicide application.

Variety	Herbicide Regime			
	Handweeded	Nortron B + B	Ro-Neet B + B	Nortron + Hoelon
	g			
HH 26	10.05^{e*}	8.99^{a}	10.56^{bc}	9.14^{b-e}
Beta 1237	10.13^{e}	10.13^{a}	9.81^{bc}	10.41^{a-c}
Mono Hy D2	11.52^{b-e}	8.47^{a}	9.39^{bc}	8.94^{b-e}
Mono Hy AS	11.53^{b-e}	9.08^{a}	10.43^{bc}	8.58^{b-e}
Mono Hy A3	12.78^{bc}	9.09^{a}	8.67^{c}	7.20^{e}
Mono Hy D7	12.87^{b}	9.93^{a}	11.21^{b}	12.02^{a}
Mono Hy A	15.41^{a}	10.76^{a}	13.36^{a}	10.42^{ab}
Mono Hy	12.74^{b-d}	9.40^{a}	9.86^{bc}	9.98^{a-d}
Mean[1]	12.13^{a}	9.48^{b}	10.41^{ab}	9.59^{b}

*Within a column, means followed by the same letter are not significantly different at the 0.05 level, by Duncan's Multiple Range Test.

[1]Column means followed by the same letter are not significantly different at the 0.05 level by Duncan's Multiple Range Test.

Experiment III - Since Experiment II suggested that cultivars may differ in their ability to detoxify certain herbicides and, hence, demonstrate differential recovery rates, an experiment was begun in 1980 designed to study post-herbicide treatment growth rate throughout the season. Beta 1237 and GW Mono Hy D2 were selected as the test cultivars because they were developed in totally unrelated breeding programs and have no common parental components. These two cultivars were subjected to pre-plant and postemergence treatment combinations of Ro-Neet plus B + B and Nortron plus B + B. Both entries also were grown without herbicide treatment. Plant dry weights were taken on 10 sampling dates beginning at 33 days after planting and continuing through harvest. Twenty-four plants per plot were sampled at each sampling date until 123 days. Thereafter 12 plants were sampled. Beta 1237 and GW D2 exhibited distinctly different growth patterns (Figure 1). At 45 days, mean plant weight for each cultivar was reduced 30-40%. In preliminary studies, reductions at 45 days were over 50%. At 63 days, GW D2 plants weighed 20% less than their untreated check counterparts, whereas Beta 1237 plants weighed the same as the check plants. For the Ro-Neet plus B + B treatment, it was not until the 103-day sampling date that GW D2 had recovered to 100% of the check. For the Nortron B + B treatment, GW D2 did not weigh 100% of the check until 123 days. After peaks in plant weight were reached, both cultivars then fell behind their equivalent untreated checks. Here again the patterns of the two cultivars were not the same. A reduction in plant weight after having once been equal to the untreated check may represent a delayed reaction to the herbicide treatment. At 140-150 days, both cultivars exhibited a linear increase in plant weight through harvest. At harvest, both cultivars under either herbicide treatment yielded about 6% less than their equivalent untreated checks. Further study is needed to determine cultivar recovery patterns following herbicide treatment.

Several conclusions can be made as a result of these three studies.

1) All cultivars do not respond equally to imposed herbicide treatments. Results demonstrate that some cultivar x herbicide interactions do occur.

2) Certain cultivars exhibit above-average tolerance to specific herbicide regimes.

3) Recovery from herbicide growth suppression differs from cultivar to cultivar. Inherent differences among genotypes in ability to detoxify certain herbicides may exist.

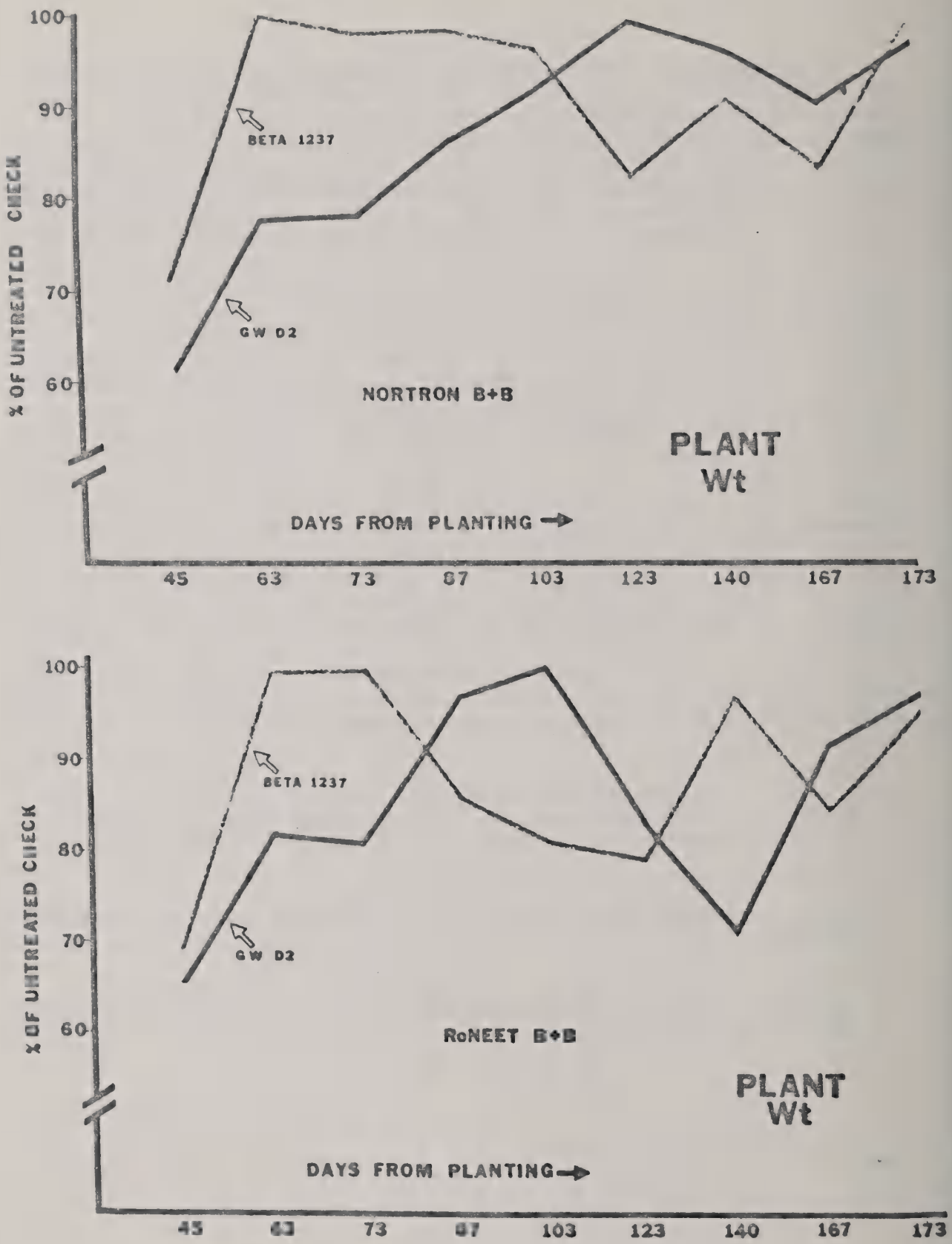

Figure 1. Total plant dry weight of two commercial cultivars as % of untreated check equivalents following preplant and postemergence herbicides.

SUGARBEET RESEARCH

1980 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

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Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
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SUGARBEET DISEASE RESEARCH - 1980

W. M. Bugbee

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Newly harvested sugarbeet roots possess little invertase activity that is detectable by conventional methods of analysis. Most of the reports in the literature further state that invertase is not detectable in stored roots. Yet invert sugars are measurable in harvested roots and accumulate during storage. Our work of several years ago showed that bacteria and yeast exist and multiply within roots, but we were not able to demonstrate invertase activity with the methods available to us at that time. This report summarizes the evidence to prove that invertase from microbial sources within the root account for the inversion of sucrose to reducing sugars. Location of the microorganisms within the root also will be described.

Localization of microbes within root tissue

Fresh sections of root tissue when examined microscopically often would show clouds of bacteria flowing from the tissue out into the water containing the tissue. Bacteria were not evident in all tissue. Dark flecks that developed on the cut surface of roots usually contained bacteria so these flecked tissues were examined with a scanning electron microscope to learn precisely where the microorganisms were located.

Bacteria and yeast were present within cells. Xylem cells contained a few but the largest concentrations were within parenchyma cells. The microorganisms were inside the vacuole and appeared to adhere to the inner vacuolar membrane. A filamentous-type bacterium had one end of the filament anchored to the membrane. Few microorganisms were seen in the intercellular spaces.

Microbial and sugarbeet invertase

Forty root discs, 1 mm x 15 mm were washed for 3 days in running aerated distilled water containing the antibiotic chloramphenicol (3 mM). The discs were then homogenized, centrifuged, and the supernatant was dialyzed. The assay for invertase activity in the dialysate showed activity was greatest at pH 5.0 - 5.5. Filtration of samples of dialysate through a calibrated gel column showed the molecular weight of the single invertase was approximately 33,000.

Invertase activity was determined in juice extracted from a sound root that had been stored for 12 months. This extraction was done with glass beads to increase the release and solubilization of invertase from microbial cell walls, especially yeast. Filtration of dialysate samples through a gel column showed the single invertase had a molecular weight of about 205,000. Dialyzed glass-bead homogenates of a pure culture of yeast had the same

approximate molecular weight for invertase. Therefore, it was concluded that the invertase activity in the stored root was caused by yeast.

The following procedure was used to increase the sensitivity of microbial invertase detection in roots. A root from the 1980 crop was peeled, cut into pieces small enough to pass through the opening of a juicerator. The pieces were submerged in 70% ethanol for 2 minutes and dried in a sterile transfer hood. Juice was extracted with a juicerator that had been flushed with 70% ethanol. Sodium sulfite (.8M) was added to the juice at 1 ml per 100 ml to prevent darkening. Juice samples were plated on nutrient agar for bacteria counts and on acidified yeast-malt extract agar for yeast and fungi. The juice was centrifuged, the pellet retained and resuspended in distilled water, centrifuged again and the pellet was suspended in 10 ml of 1 M NaCl. The suspended pellet was homogenized in a Polytron homogenizer for 0-3 minutes, centrifuged, and the supernatant was dialyzed against glass distilled water. An invertase assay of dialysate of the unhomogenized pellet showed the greatest activity at pH 5.8 and another broad peak at pH 7.0 -7.8 (highest pH tested). Culture plate counts showed the microbial population consisted largely of bacteria with relatively few yeast. Gel filtration of samples of dialyzed extract showed at least two peaks of activity. Neither peak corresponded to sugarbeet invertase in molecular weight. Modification of gel filtration must be done to increase peak resolution and estimate molecular weights.

Discussion

Microorganisms inhabit cells of healthy sugarbeet roots. Bacteria are prevalent in freshly harvested roots, multiply during storage of the root and contribute largely (probably entirely) toward the hydrolysis of sucrose through the production of neutral invertases. As roots age in storage and the pH drops due to bacterial metabolism, yeast growth is favored and sucrose is hydrolyzed largely (probably entirely) by acid invertases produced by yeast and other fungi.

The avenues of entry into the root have not been determined but the presence of bacteria and yeast within seeds and germinated seeds indicate that one avenue may be the flower. If so, microorganisms could inhabit and be a part of dividing cells early in the plants growth cycle. This mechanism of entry is easier to accept than microbial penetration of intact cells.

The development of storage germplasm with inherent low invert sugar accumulation would be very difficult because the microbial population within roots probably fluctuates from year-to-year depending on many environmental and physical factors that affect root entry and growth of the microbes.

Other impurities that accumulate in the healthy root during storage also may be caused by microbial metabolism.

Storage Rot Response of Hybrids With a Rot Resistant Pollinator

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Hybrids of F1001, a rot resistant line, and 6 cytoplasmic male sterile lines were obtained from the USDA breeding program at Ft. Collins, Colorado. Hybrids and parents were grown in a randomized complete block design with five replications. Responses to three important rot fungi (Phoma betae, Botrytis cinerea, and Penicillium claviforme) were recorded after storage at 10 C for 90 days.

Rot ratings are presented in Table 1. With one exception (A12 MS/AI-16 CMS for Phoma response), F1001 had significantly lower disease ratings than

Table 1. Rot ratings of parents and F_1's of crosses between F1001 and commercial CMS lines.

Crosses and parents	Phoma	Botrytis	Penicillium
	rot rating †		
642027SL/662119SL CMS	3.2 ab*	4.5 b	4.9 a
" " //F1001, F_1	2.2 c	2.3 g	4.0 ef
652016SL/662119SL//FC506 CMS	3.4 a	4.6 ab	4.9 a
" " " /3/F1001,F_1	2.3 c	3.2 e	3.9 f
63-5HO/6 CMS	3.0 ab	4.2 bc	4.9 a
" " //F1001,F_1	2.2 c	2.9 f	4.2 d
KWS MS	3.1 ab	4.1 c	4.8 ab
" //F1001,F_1	2.2 c	2.8 f	4.2 de
AI-2 MS/AI-16 CMS	2.1 c	4.6 ab	5.0 a
" " //F1001,F_1	2.1 c	3.3 e	4.6 bc
FC607 CMS	2.9 ab	4.9 a	5.0 a
" /F1001,F_1	2.3 c	3.7 d	4.5 c
F1001	1.9 c	2.0 g	3.5 g
CMS parent mean	3.0	4.5	4.9
F_1 mean	2.2	3.0	4.2
Mean	2.5	3.6	4.5
ACH-30	3.2	4.4	5.0

† Rot rating indicates the distance rot progressed through a 1 CM^3 block of root tissue after incubation at 20 C for 2 weeks. 0 = 0 mm; 1 = not more than 2 mm; 2 = 2-4 mm; 3 = 4-6 mm; 4 = 6-8 mm; 5 = 8-10 mm (entire block).

* Means followed by the same letter are not significantly different (Duncan's Multiple Range Test) at the .05 level of significance.

the CMS parent. Phoma ratings for F_1's were not significantly higher than F1001 ratings. Botrytis ratings were generally higher for the F_1's than for F1001 but were in all cases lower than the female parent. Differences in disease ratings for Penicillium indicated that F_1's were intermediate to the two parents; however, differences were generally small. These results indicate that the use of a rot resistant pollinator would be instrumental in producing hybrids with improved rot resistance. The relationship between disease ratings and economic losses in storage piles is not clear and the degree of resistance necessary to noticeably improve storability needs to be explored.

SUGARBEET RESEARCH

1980 Report

Section E

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Farmers and Manufacturers Beet Sugar Association
Michigan Sugar Company
Monitor Sugar Division
Michigan Agricultural Experiment Station
American Crystal Sugar Company

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CONTENTS

HYBRID EVALUATIONS

G. J. Hogaboam and J. W. Saunders

The two hybrid evaluations reported here represent the first evaluations of various combinations. We are indebted to the Farmers and Manufacturers Beet Sugar Association and the American Crystal Sugar Company for raising test quantities of these hybrids in their pollinator fields and providing them to us for testing. The F&M also cooperates in the testing and evaluation for quality.

The USDA - F&M hybrid test of 24 hybrids revealed 12 hybrids with significantly less recoverable white sugar per acre than US H20. Only 3 had significantly less yield of roots per acre than US H20. Thirteen hybrids had significantly lower quality (recoverable white sugar per ton) than US H20. All hybrids were equal to or better than US H20 in leaf spot resistance with six significantly better.

Experiment 11 was designed to detect any significant changes that may have been made in the lines EL44 and EL45, during their selection to improve their seed production ability. In Table 11, A and A' were used to designate lines with similar parentage to EL44 (designated A")and B and B' were used to designate lines with similar parentage to EL45 (designated B"). Eight different pollinators were used in the test with ' designating a different year of seed production. The data indicate no significant change in the yield of roots per acre or recoverable white sugar per acre, but there was a significant improvement in quality as measured by % sucrose, % clear juice purity and recoverable white sugar per ton. There was also a significant loss in leaf spot resistance, as measured on Sept. 4, at East Lansing, MI. One can only speculate on the cause of these quality improvements, since no selections were made to improve them. Our speculation is that EL44 and EL45 had had fewer generations of increase and thus less chance for contaminent pollen to change the characteristics.

USDA - F&M Nursery Hybrid Test
1980

Entry No.	Variety
1	SP75572-01 X 76745-0 ms X SP6822-0
2	SP70756-01 X " " "
3	SP74566-01 X " " "
4	SP73747-01 X " " "
5	EL36ms X " " "
6	EL45ms X " " "
7	USH20
8	FC506ms X 76745-0 ms X SP6822-0
9	EL31ms X " " "
10	563HO X " " "
11	SP77612-01 X " " "
12	SP77613-01 X " " "
13	EL44ms X FC506 " "
14	SP7542-01 X " " "
15	551HO X " " "
16	Mono HY E4
17	SP76745-01 X FC506 " X SP6822-0
18	EL36ms X " " "
19	SP71550-01 X " " "
20	F&M H3
21	SP6926-01 X UI12167B-11 ms X SP6822-0
22	FC606ms X "
23	SP76682-01 X SP77756-0 GCSI X SP6822-0
24	SP74324x1 X SP71621-0 X SP74566-0 X SP6822-0

USDA - F&M Nursery Hybrid Test - 1980

Vassar, Michigan

Entry No.	RWSA	T/A	RWST	% S	% CJP	Beets/ 100 Ft.	Leaf Spot*
1	6504	27.82	234	14.89	91.12	84	4.7
2	6240	26.31	237	14.97	91.48	78	5.0
3	6658	28.83	232	14.81	90.91	87	5.0
4	5478	23.38	234	14.86	91.34	60	4.7
5	6264	26.78	234	14.89	91.10	80	5.3
6	6439	26.99	238	15.17	91.11	84	5.0
7	7104	27.82	255	15.70	92.65	93	5.3
8	6416	25.93	248	15.53	91.72	79	4.3
9	5995	26.00	231	14.72	91.03	79	5.0
10	5712	25.92	221	14.31	90.36	78	5.0
11	6494	27.27	238	15.18	91.01	83	4.0
12	6022	24.91	242	15.30	91.39	72	4.0
13	6634	26.49	250	15.53	92.16	83	4.3
14	6566	26.84	245	15.41	91.55	80	3.7
15	6141	25.87	238	15.04	91.34	80	4.7
16	6902	26.29	262	16.18	92.42	90	3.7
17	6395	25.51	251	15.55	92.32	84	4.0
18	6685	26.91	256	15.45	92.04	83	4.3
19	6454	26.03	248	15.48	92.00	76	3.3
20	6673	26.96	248	15.38	92.22	88	5.0
21	6539	26.39	248	15.41	92.12	84	4.7
22	6550	26.42	248	15.50	91.83	76	5.0
23	6323	26.49	239	15.08	91.44	83	4.7
24	6723	28.75	234	14.97	90.93	90	4.7
GEN. MEAN	6413	26.54	242	15.22	91.57	81	4.6
LSD (5%)	620	2.26	13	0.56	0.85	10	1.1
CV (%)	8.4	7.4	4.7	3.2	0.8	10.7	14.2

Location: Rudy Mossner Farm
Cooperation: Michigan Sugar Co.; F&M Beet Sugar Assn.
Planted: May 5; Harvested: October 8; Row Width: 28 inches
Disease: Light leafspot
Reliability of Test: Very good
*Beltsville, Md. readings; Dr. Coe; July 30; 3 reps.

Table 11. Comparison of EL44 and EL45 (A"xB") with (AxB) or (A'xB') representing lines from which EL44 and EL45 were selected, tested in combination with 8 different pollinators (' on numbers designates a different year of seed production).

Hybrid Code	Entry No.	RWSA	T/A	RWST	% Sucrose	% CJP	E. Lansing L.S. 8-19	9-4
A' x B' x 1'	1101	6330	24.39	259.8	15.39	94.62	3.3	4.3
A" x B" x 1'	1102	5888	22.38	264.1	15.58	94.80	3.7	5.3
A' x B' x 4	1103	6087	24.25	261.7	15.58	94.32	3.3	5.3
A" x B" x 4	1104	6541	24.53	266.8	15.86	94.39	3.3	5.0
A' x B' x 2'	1105	6002	24.50	245.3	14.88	93.47	3.7	5.3
A" x B" x 2'	1106	6084	24.22	250.7	15.17	93.56	4.0	6.0
A' x B' x 3'	1107	5989	23.66	253.4	15.04	94.59	2.7	4.0
A" x B" x 3'	1108	5497	21.11	260.3	15.37	94.81	3.0	4.3
A x B x 2	1109	5496	22.99	240.0	14.96	92.12	4.0	6.0
A" x B" x 2	1110	6147	25.20	243.7	14.88	93.16	4.0	6.3
A x B x 3	1111	5638	22.71	249.7	14.96	94.11	2.7	4.0
A" x B" x 3	1112	5256	20.71	254.6	15.15	94.43	3.0	4.3
A x B x 5	1113	5554	19.85	280.1	16.44	94.98	3.3	5.0
A" x B" x 5	1114	6837	24.30	282.0	16.56	94.91	3.3	5.3
A x B x 6	1115	5390	21.17	254.5	15.44	93.39	3.7	5.3
A" x B" x 6	1116	5048	19.68	256.5	15.45	93.76	4.0	5.7
A x B x 1	1117	5210	20.36	255.7	15.42	93.71	3.0	5.0
A" x B" x 1	1118	6018	23.36	257.7	15.39	94.20	3.0	5.0
A" x B" x 7	1119	4738	19.17	247.7	14.89	93.97	3.0	4.3
A" x B" x 8	1120	5229	20.40	256.5	15.20	94.63	3.0	4.3
US H2O	1121	5223	20.78	250.7	14.98	94.25	3.0	4.3
US H2O	1122	5710	23.15	246.4	14.89	93.68	3.0	5.0
US H2O	1123	6381	24.31	263.2	15.51	94.86	3.0	4.7
US H2O	1124	6136	23.95	256.5	15.20	94.63	3.0	4.7
	GM	5768	22.50	256.6	15.34	94.14	3.3	5.0
	LSD5%	NS	NS	12.4	0.51	0.81	0.8	1.1
	CV%	18.2	18.5	4.2	2.92	0.75	14.1	12.8
				Among first 18 entries above				
Males	1'	6109	23.38	261.9	15.49	94.71	3.5	4.8
	1	5614	21.86	256.7	15.40	93.96	3.0	5.0
	2'	6043	24.36	248.0	15.02	93.52	3.9	5.7
	2	5822	24.10	241.9	14.92	92.64	4.0	6.2
	3'	5743	22.39	256.8	15.20	94.70	2.9	4.2
	3	5447	21.71	252.2	15.05	94.27	2.9	4.2
	4	6314	23.89	264.2	15.72	94.35	3.3	5.2
	5	6196	22.07	281.1	16.50	94.94	3.3	5.2
	6	5219	20.43	255.5	15.44	93.57	3.9	5.5
Females (A x B) or (A' x B')		5743	22.54	255.6	15.35	93.92	3.3	4.9
A" x B"		5923	22.83	259.6	15.49	94.22	3.5	5.2
	GM	5834	22.69	257.6	15.42	94.07	3.4	5.1
Males	LSD5%	NS	NS	2.5	0.21	0.46	0.6	0.6
Females	F-test	NS	NS	45.30**	8.50*	7.75*	NS	7.20*
	CV%	16.90	17.31	4.42	3.06	0.80	15.62	8.96

CLONAL SYNTHETICS

By

G. J. Hogaboam and J. W. Saunders

Seedstalks of 117 monogerm roots, selected from 12 outstanding progenies of the Bean and Sugarbeet Research farm at Saginaw, Michigan, were allowed to interpollinate in the greenhouse during the winter of 1976 - 1977 at the 77B1 seed production location. Each root was cloned using seedstalk cuttings. A vigorous ceiling fan was run constantly during the pollinating period and the pollen was daily blown into the air from each plant.

The open pollination seed from each mother beet was used to evaluate the progeny performance in: sand emergence, yield ability and processing quality in an agronomic test, as well as resistances to Aphanomyces black root, Cercospora leaf spot, and Rhizoctonia crown and root rot.

A decision was made to use the clones to develop monogerm breeding material with improved recoverable white sugar per ton and improved clear juice purity. Our research and that of others indicate that the quality characteristics are involved in general combining ability, whereas the yield characteristics are more dependent on specific combining ability. Therefore, one should use material that has been improved in this general combining ability when searching for specific combinations to maximize yield of recoverable white sugar per acre (at a reduced energy cost for hauling, handling, and evaporating water associated with highest tonage beets).

Clones of 7 of the original 117 monogerm roots were selected for the 78B1 synthetic on the basis of the superior performance of their progeny in the 1977 evaluations of 77B1 seed lots. These progeny were selected specifically for their high clear juice purity coupled with high recoverable white sugar per ton and above average disease resistance.

The 78B1 seed (pooled by clonal parent) was tested in 1978 versus the 77B1 remnant seed produced on the same roots. The results, Table 1, represent differences in the male gamete pool in 77B1 (117 roots) versus 78B1 (7 roots), since the female gametes came from the same roots. Only four of the seven roots involved in 78B1 could be compared here as we were out of remnant seed of 3 of the 77B1 seed productions from these roots. This also precluded their inclusion in the selections for the 79B17 (and the paired 79B16) seed production. Although the comparisons of CJP and RWST for the progenies of the four seed parents all indicated progress in the direction of selection, there was not enough to detect more than one significant difference.

In the fall of 1978, comparable size and number of roots were taken from selection plots of each of the 77B1 and 78B1 half-sib families that had been evaluated that year. Mother roots taken from 78B1 progenies were interpollinated in the field during the summer of 1979 at seed isolation 79B16, while those mother roots taken from 77B1 were interpollinated at the 79B17 seed isolation.

Seed was harvested by individual plants at each location. Emergence tests in sand were made on each seed lot and those with less than 50% emergence or more than 20% multiple emergence sites were dropped from further evaluation. Seed lots were then "paired" for an agronomic evaluation in 1980, such that there were an equal number of seedlots tracing back to a common parent root selected in 1976. Half of the seed lot entries (24) had been produced on roots selected from the clonal synthetic (78B1) and the other half had not. The 1980 results are also given in Table 1. All results are related to the performance of US H20, which was grown in every test, in an attempt to partially remove environmental effects between years involved in the tests. Calculations of percent performance of US H20 are made such that all desired percentages have higher values than do less desirable ones. It should be noted that the relative performances in 1977 differed from those of the same seed lots tested in 1978 (77B1) which indicates the existence of environmental interactions. In 1978, the 6 replications were used to check for significant differences between 78B1 and 77B1 performance. Since the degrees of freedom for the t value was so small the differences observed over 6 replications were in all but one case not large enough for significance. The 1980 t tests were made using unpaired t test where the variable was the 6 replication average performance among the seedlots tracing to the same 1976 selected root. This lowered the variability which resulted in many significant differences. When all 24 seed lots of each seed production were compared, there was a significant gain in the selection criteria for the synthetic generation (78B1), namely, %clear juice purity and recoverable white sugar per ton without having to do any individual root analysis. There was a significant loss, however, in tons of roots per acre, which also made a significant loss in recoverable white sugar per acre.

We feel the objectives of the 78B1 synthetic were achieved as evidenced by the performance of the 79B16 in regard to quality. "O" types taken from this line should furnish a better source of material with which to search for specific combinations for higher yield.

Table 1. Percent performance relative to US H20 with significance between seedlots determined by unpaired t tests on actual data.

1976 Selected Mother Root Number	G303-4				G303-9				G317-2				G328-3			
Seed Produced in Pollen Group	78B1		77B1		78B1		77B1		78B1		77B1		78B1		77B1	
Year of Test Results	'78	†	'78	'77	'78	†	'78	'77	'78	†	'78	'77	'78	†	'78	'77
Recoverable White Sugar/Acre	87.7	NS	82.6	79.8	78.0	NS	92.0	98.6	95.5	NS	86.6	94.9	96.6	NS	88.3	99.6
Tons/Acre	92.4	NS	89.7	81.0	81.1	NS	100.0	102.5	101.0	NS	92.4	98.3	102.2	NS	97.1	103.9
→Recoverable White Sugar/Ton	94.9	NS	92.0	97.7	96.1	NS	92.0	96.3	94.4	NS	93.7	96.4	94.3	NS	90.9	96.5
Percent Sucrose	96.0	NS	93.7	98.0	96.7	NS	93.9	98.8	95.0	NS	94.3	97.6	94.6	NS	92.4	98.5
→Percent Clear Juice Purity	99.4	NS	99.2	99.9	99.7	*	99.1	98.7	99.8	NS	99.8	99.4	100.0	NS	99.3	99.0
Rhizoctonia				117@				114				100				113
Leaf Spot				122@				122				122				122
Selected progeny of above seed tested in 1980.																
Seed Produced in Pollen Group	79B16		79B17		79B16		79B17		79B16		79B17		79B16		79B17	
No. of Seed Lots Tested	8 of 14	†	8 of 16		3 of 5	†	3 of 12		6 of 17	†	6 of 15		7 of 8	†	7 of 15	
Recoverable White Sugar/Acre	80.4	**	90.9		72.5	*	89.2		84.1	NS	88.8		80.1	*	90.2	
Tons/Acre	79.9	**	91.4		73.1	*	92.0		84.5	NS	90.7		76.9	**	91.1	
Recoverable White Sugar/Ton	100.6	NS	99.0		99.1	NS	96.4		99.0	NS	97.7		103.6	*	98.6	
Percent Sucrose	101.2	NS	100.1		99.4	NS	98.7		99.1	NS	99.1		102.7	NS	99.9	
Percent Clear Juice Purity	99.7	NS	99.4		99.9	*	98.8		100.0	NS	99.3		100.4	**	99.3	
Leaf Spot	121@		124		125		121		134		138		133		131	

	Average of above 24 seed lots each			'77 Performance 77B1- Seed	
	79B16	†	79B17	All	Sel. for 78B1
Recoverable White Sugar/Acre	80.2	**	90.0	88.9	94.3
Tons/Acre	79.3	**	91.2	96.1	95.4
Recoverable White Sugar/Ton	100.9	**	98.2	92.3	98.6
Percent Sucrose	100.9	NS	99.6	95.0	99.7
Percent Clear Juice Purity	100.0	**	99.3	98.6	99.4

@ higher ratings indicate more resistance to disease = US H20 rating ÷ seed lot rating.

→ main considerations for selections.

† indicates significance level between numbers on either side of sign.

UTILIZATION OF *IN VITRO* SHOOT CULTURE IN THE BREEDING PROGRAM

Joseph W. Saunders

Employing the method for *in vitro* vegetative propagation described in the 1979 Bluebook, we scaled up the 1980 shoot culture effort to around 120 genotypes, most from a single greenhouse polycross seed production, in order to determine whether it is practical in terms of time and labor to propagate and maintain germplasm in this way. Accordingly, lateral buds 5-15 mm long were taken from flower stalks in Jan.-Feb., decontaminated with two 15-minute soaks in 15% chlorox -0.01% sodium laurylsulfate followed by six washes in sterile distilled water. These buds were placed onto the surface of 10 ml of Murashige-Skoog medium (Physiologia Plantarum 15:473-497, 1962) containing 0.25 mg/l benzyladenine in 6-dram screw cap glass vials. More than 80% of the buds were decontaminated by this procedure. Subdivision of the branching shoots and transfer to fresh medium was done in Feb.-March, induction of roots on shoots in April-May, and transplanting to field in May-June.

By July we had transplanted more than a thousand ramets to the field for increase of root size, which should be proportional to seed production potential. There was an average of nearly ten ramets per genotype overall, with two O-genotypes having more than a hundred ramets each. (Although not in common usage yet, ramet is a term proposed several years ago to denote identical genetic copies. The term clone is not considered specific enough, as it has been used in the past as a collective term for all copies of a genotype, as well as in reference to individual copies. We will continue to use the word clone in a collective sense.)

In November ramets were dug and placed into three greenhouse seed production isolations. One grouping of ten clones was based on progeny performance in agronomic and disease resistance tests, and included only newly identified O-types. Another grouping involved ramets of the four newly identified O-types with the most *Rhizoctonia* resistant progeny. Thus, having enough ramets of a given clone allowed us to make more than one grouping of clones for the second stage of the polycross operation.

Rhizoctonia Resistance Reaction of Ramets. In a pilot test conducted with Dr. Charles Schneider to see how well crown rot resistance could be distinguished using ramets, 138 ramets representing seven genotypes were transplanted into the field on June 13 and inoculated with *Rhizoctonia* on July 23. Roots were dug and scored for crown rot on Sept. 19 on a scale of 0 to 4, with 0 denoting no evidence of infection per ramet and 4 indicating death.

Clone	Disease Rating	No. of Ramets
FC 701/5-208	0.87 ± 0.49	31
FC 701/5-206	0.95 ± 0.49	21
FC 701/5-207	1.00 ± 0	3
EL 36-18	2.00 ± 0.63	5
SP 6822-17	2.05 ± 0.60	51
G335-18E	2.15 ± 0.86	13
EL36-15	3.00 ± 1.13	14

Analysis of scores indicated that Rhizoctonia resistance is manifested at the ramet level in the field, although in a somewhat variable manner. Three clones from the resistant check line FC701/5 clearly were more resistant than clones from the two susceptible lines EL36 and SP6822 and a clone of a randomly selected genotype from the local breeding program. It was concluded that ramets, despite being somewhat more sprangled because of transplanting and prior root induction on shoot structures, manifest a characteristic resistance or susceptibility to Rhizoctonia crown rot in the field.

INDUCTION OF FOLIAR ADVENTITIOUS SHOOTS BY BENZYLADENINE

Benzyladenine (BA) is a synthetic cytokinin, the class of plant hormones important in maintaining in vitro shoot cultures in sugarbeet and in stimulating shoot differentiation in vitro in many other species. In initial screening of growth regulators on seedlings in a search for possible inducers of flowering in beets, graduate student Martin Mahoney noted that 1000 mg/l BA caused adventitious shoot formation on seedlings of EL44. Subsequent tests in the growth chamber and greenhouse have demonstrated that BA in a concentration range of 33-2000 mg/l sprayed once onto cotyledon-stage seedlings of EL44 and EL40 induced adventitious shoots and leaf anomolies on subsequent leaves, primarily on the third through twelfth true leaves.

Up to 50% of EL44 plants developed adventitious shoots, whereas at most 10% of EL40 plants did. Growth rate of EL44 plants was more sensitive to BA, with plants treated with 500 mg/l BA producing only 10% (EL44) and 33% (EL40) of control dry weight after four weeks growth.

The phenomenon of cytokinin induction of foliar adventitious shoot production on intact plants appears to be unique to beets. It is similar to the two other systems in which adventitious shoots arise in beets (shoot culture and isolated shoot culture leaf parts) in that adventitious shoots arise only on leaves formed after exposure to the cytokinin. However, no system for production of adventitious shoots from callus or isolated leaf parts of intact plants has been reported. If a screening of different lines indicates that EL44 is more sensitive to cytokinin effects on growth and adventitious shoot induction, then it may prove useful in attaining shoot regeneration in the desired systems of callus and intact plant leaf pieces.

RAPID FLORAL INDUCTION OF BEETS

Joseph W. Saunders

Conditions for evaluating the sensitivity to rapid floral induction of breeding lines in the growth chamber were standardized at 24-0 hr incandescent light (25-35$\mu Em^{-2}s^{-1}$) and 14-10 hr fluorescent (350-550$\mu Em^{-2}s^{-1}$) with a 14-10 hr 20-14 C temperature cycle coinciding with the day-night cycle. The variability of light intensity from one experiment to another resulted from use of fresh bulbs in some tests and used bulbs in others. We have started to use fresh bulbs for each experiment now because, in a retrospective look at experiments, higher fluorescent light intensity appears to promote more rapid flowering, whereas higher incandescent light intensity appears to promote flowering in a greater proportion of genotypes in a population.

Three different plant systems have been found sensitive to rapid floral induction using continuous incandescent light: seedlings, shoot culture ramets, and isolated crown buds.

Seedlings. In this system seedlings emerge under the standard conditions, and populations are exposed to the standard temperature and light environment. Usually a portion of any particular population flowers. Presumably the genotypes that flower under the standard conditions would be the most bolting prone in the field, but this has not been tested. A summarizing of several experiments at different light intensities follows; it is not meant to be an unconfounded comparison of breeding lines, but should give an idea of the range of sensitivity that we've found.

VARIATION IN RAPID FLORAL INDUCTION AMONG BREEDING LINES

Line	Proportion Flowering after 80 days	%
FC701/5	41/48	85
EL42	16/16	100
SP6822	14/32	44
EL40	12/29	41
EL39	5/16	31
EL44	4/32	13
EL41	1/16	6
2512*	0/32	0

* bolting-resistant inbred from John McFarlane.

FC 701/5 appears to be the most sensitive line we've tested. In one experiment, all sixteen plants had started to bolt by 27 days after emergence and flowered by 50 days. In the only test run so far to see if plants would flower if placed into the standard conditions some while after emergence, ten FC701/5 plants were started at 14-10 hr incandescent and fluorescent and 20-14 C, then shifted to continuous incandescent after five weeks. Six of

the ten plants flowered, with a mean time of 65 ± 5 days to first flower. The relatively low proportion flowering and the long time to flower may have been caused by the lower light intensity, as the bulbs had already been in use for five weeks when the ten plants were placed in that chamber.

Conditions for rapid floral induction have probably not been optimized, and this would account for the fact that only 44% of the seedlings tested in a total of eight lines have flowered under the standard conditions. Another way to view this fact is to see the standard environment as a differentiating system, which separates the more sensitive flowering ("bolting") genotypes from the more resistant. The system thus lacks the safety feature of the customary cold induction method which delays the growth response to the inductive stimulus until even the most insensitive genotype has had time to receive a sufficient amount of stimulus, whereupon all can leave the starting gate together, as it were, when brought out of the cold. This is because the cold serves not only as inducer in the customary induction method, but also as an inhibitor of the growth response to the stimulus. Thus, cold induction of sufficient duration appears not to serve as a differentiating system capable of separating the bolting-sensitive from the bolting-resistant genotypes. Consequently, the standard conditions that we've used for rapid floral induction might be used in evaluating lines for inherent (as opposed to contaminant) bolting sensitivity, as well as for selection of either easy or difficult bolters.

Ramets. Two genotypes were tested for early floral induction using several dozen ramets of each. Rooted shoot culture shoots were potted up in Metro Mix 300, watered with Peters nutrient solution, and after two days of hardening in the shade, were put into the standard conditions in the growth chambers. For clone 427-8, 26 of 33 ramets flowered in a relatively low fluorescent and incandescent light intensity with a mean time of 86 ± 16 days to first open flower. Under peak light intensity, clone 448-3 had 45/46 ramets bolting with a mean time of 28 ± 8 days to first bolt. Most ramets were then removed from the chamber prior to flowering. Some were planted in the field for seed production. Best stage for transplanting bolting ramets, and this may apply to bolting young plants as well, appeared to be relatively soon after bolting starts. For the purpose of matching flowering times, transplant of more advanced bolters appeared to increase the risk of stressing the plant and delaying the peak of flowering several weeks until a new flush of floral stalks could grow up.

It is still not understood why there is a significant portion of ramets of a given clone that do not bolt or flower. However, as there will be no selection for easier bolting within a population of ramets of the same clone, it would appear that at present the method of continuous incandescent light for rapid floral induction is most suited for use with ramets, and particularly for backcrosses. We are currently using rapid floral induction with ramets of newly identified O-types. We can keep stocks of the clones on hand as in vitro shoot cultures, then induct roots and flowering when desired. At a given combination of temperature regime, light regime and light intensity (the importance of the latter is increasingly being realized), we can characterize each clone as to speed to flower and possible proportion of ramets bolting as well. Collection of pollen for storage and later use in backcrossing to produce male sterile equivalents is possible with the inducted ramets

if the prospective seed parents in a cross are not flowering at the same time.

Isolated Crown Buds. Crown buds were excised from beets in the field in Oct.-Nov., at which time they had probably been exposed to many cold nights. The buds had leaves up to 30 cm long, and were cut from the mother root with a scalpel so as to leave a wedge of root tissue attached. They were dipped into Rootone and placed in Jiffy-7 peat pots in clear plastic covered trays in a growth chamber at 24 C. Two problems developed: pest control on the crown buds during the next 3-4 weeks while they were not growing, but attempting to establish a root system, and the actual root induction, which was hindered to some extent by the aphid population which appeared to have been brought in from the field.

Those crown buds which did take root were potted up and placed in the standard growth chamber conditions for rapid floral induction. Nearly 70% of the genotypes sampled were bolting within seven weeks, although most of the genotypes had been taken from roots of FC701/5, which had a high number of crown buds in the field.

Although the use of rapid flowering of isolated crown buds might be seen in early test crosses of a genotype while the mother root is kept in cold storage for possible seed production the following season, or as a source of lateral buds for shoot culture establishment, the problems with pest control, root induction, and selection of relatively easy-flowering genotypes make this method of limited attractiveness. Furthermore, the presence of crown buds of sufficient size and perhaps number is necessary. This varies from line to line, and also depends on stand density. Unfortunately, those beets most likely to possess suitable crown buds are those least desirable for selection because they will probably be in an incompletely competitive stand position.

Current Limitations on Use. In terms of general applicability, the use of continuous incandescent light for rapid floral induction will probably see limited service for two reasons. First, because in heterogeneous populations only a proportion of the population will flower, selection for increased bolting sensitivity will occur if only that proportion is used for crossing purposes. Secondly, optimum results can be produced in the growth chamber because of the apparent importance of temperature control and light intensity. Growth chamber space is limited and/or expensive. Although greenhouse application has not been tried, the need for space for larger populations could best be satisfied in the greenhouse during cold weather when temperature control is more feasible. Light intensity would probably have to be kept high artificially. Efficient use of growth chamber space is possible if plants are taken out as soon as they start bolting, and kept in conditions which preclude reversion to the vegetative state.

Sugarbeet Pathology

C. L. Schneider

I. Testing for disease resistance.

A) Black root disease (Aphanomyces cochlioides) - Greenhouse screening tests were conducted from January through March. Seed was planted in 10.2-cm styrofoam pots of steam-pasteurized potting mix. Dried oospore inoculum on vermiculite or Turface carrier was added to soil at planting (50×10^3 spores/pot). Disease severity was assessed about 6 wks. after planting. There were 4 experiments with a total of 415 entries. Var. US H20 was included in each test as standard for comparison. Results are summarized in Table 1. In 3 of the tests there were significant differences among entries. The C.V.'s indicate that the general reliability of the tests is good.

Table I. Summary of 1980 greenhouse screening tests of Aphanomyces black root disease resistance of sugarbeet lines.

Exp. no. and type of material	No. entries	D.I.[1/] US H20 Mean	Entries Mean	Entries Range	C.V. %	No.[2/] superior entries
80-1 E.L. breeding lines	316	3.1	2.7	2.1-3.5	10.0	113
80-2 E.L. experimental hybrids	25	3.0	2.2	1.7-2.5	15.6	25
80-3 F&M lines	6	2.7	2.7	2.3-2.9	18.9	0
80-4 E.L. breeding lines	68	3.2	2.9	2.3-3.1	15.6	18
Totals	415					156

1/ DI (disease index) = 0 (no symptoms) - 5 (dead).

2/ Entries with DI significantly below that of US H20 (P=0.05).

B) Root rot (Rhizoctonia solani) - The Rhizoctonia nursery was planted on 21 May with single-row plots, 7-m long. There were 4 experiments, 3 comprising 4 randomized blocks and one comprising selection plots, each of 3 adjacent rows. There were a total of 151 entries. On 10 and 11 July, barley grain inoculum was applied for a total of 18cc/m of row. Plots were sprinkler-irrigated on 12, 13, 14 July. Plots were harvested and plants rated according to disease severity on 5-8 Sept. (exps. 900 and 1000), 27-30 Oct. (exps. 800 and 1200) and 7 Nov. (selection plots). Results are summarized in Table 2. Average root rot level in US H20 = 63%, about the same as in 1979 (68%), but lower than in 1978 (82%) and 1977 (83%). Plots of check variety FC701/5 were severely damaged by the chronic phase of black root disease. The general reliability of the tests is considered good with C.V.'s = 15.9-19.6%.

Table II. Summary of 1980 tests of root rot resistance of sugarbeet entries in the Rhizoctonia nursery.

Exp. No.	No. entries	Pct. root rot: Checks US H 20 $\bar{x}$	Checks EL42 $\bar{x}$	Entries $\bar{x}$	Entries Range	C.V. (%)	No.[1/] superior entries
800	32	62	45	44	35-55	16.5	28
900	33	63	41	50	47-71	15.9	8
1000	23	59	-	52	44-62	19.6	1
1200	19	69	-	49	28-69	17.7	13
Selections	44	62	44	49	34-72	15.8	19
Total or Mean	151	63	44	49	28-72		69

1/ Entries with pct. root rot significantly below that of US H20 (P=0.05).

C) Leaf spot disease (Cercospora beticola) - A total of 245 entries were tested in the Cercospora nursery. Plots, planted 16 May, comprised one 7-m row. There were 9 experiments, each with 3 randomized blocks. Dried sugarbeet leaf inoculum was mechanically applied in the leaf rosettes at 0.4 cc/m of row on 9 July. The plots were sprinkler irrigated on 14 July. Disease intensity readings were made on 19 Aug. and 5 Sept. The results, in Table 3, show the majority of entries superior to US H20 check in resistance.

Table III. Summary of tests of sugarbeet lines for leaf spot disease resistance in East Lansing Cercospora nursery in 1980.

Experiment no.	No. entries	D.I.[1/] US H20 $\bar{x}$	D.I.[1/] Entries (range)	D.I.[1/] C.V. (%)	No.[2/] superior entries
700	54	5.2	2.7-5.3	14.2	46
800	34	5.0	2.7-5.0	10.6	29
900	24	5.3	3.0-4.7	13.3	23
1000	23	4.8	2.7-3.7	14.1	18
1100	20	4.6	4.0-6.3	12.8	0
1300	47	5.0	3.0-5.0	13.7	37
E	15	5.0	2.3-5.7	13.5	10
N	23	5.0	4.0-5.3	14.3	0
C	5	4.0	3.3-5.3	13.7	0

1/ DI (disease index) - 0 (no symptoms - 10 (complete defoliation).

2/ Entries with DI significantly below that of US H20 check (P=0.05).

II. Tests of fungicides and biological control agents.

A) Seedling blight - The efficacy of seven seed treatments and two soil treatments was tested for control of seedling blight in two lots of commercial cultivar, US H20. Lot #1 was relatively free of Phoma betae seed infection and treatments were applied for control of soil-borne pathogens. Lot #2 was heavily infested with Phoma and treatments were applied for control of seed-borne Phoma as well as soil-borne fungi.

The seed was planted on 28 May (51 days after treatment) in soil naturally infested with seedling blight fungi, including Aphanomyces cochlioides, Pythium spp., and Rhizoctonia solani. Plots, each comprising one 7-m row were arranged in 4 randomized blocks. Immediately after planting, Previcur N70S soil treatments were applied, incorporated with the herbicides Pyramin (177 g/km of row) and TCA (184 ml/km of row) in a 20-cm band over the row at rates of 92 and 184 ml product/km of row. Control soil treatment comprised herbicide alone.

Results are presented in Table 4. Prethinning (26 June) and post-thinning (1 July) stand counts show that Lesan 70W soil treatments resulted in seedling stands significantly greater than that of the controls. The soil treatments had no significant effect on stands at 5% level. In Test #2, seed-borne Phoma apparently had no effect on seedling stand. Inasmuch as this experiment was planted relatively late, the warmer temperatures are probably responsible for the lack of Phoma damage.

Table IV. Results of two sugarbeet seed treatment tests at E. Lansing, MI in 1980.

Seed lot, treatment and rate (product/100 kg)		Pct[1/] Phoma in seed	No. plants/plot[2/] Pre-thin	Post thin
Test 1				
Lot #1	Lesan 70W (125 g)	-	34.8 ab	13.1 ab
	Lesan 70W (250 g)	-	48.2 b	17.2 b
	Previcur N70S (450 ml)	-	27.9 a	11.6 a
	Previcur N70S (900 ml)	-	27.7 a	12.5 a
	Terracoat L-205 (782 ml)	-	21.7 a	11.6 a
	Untreated control	-	23.0 a	11.5 a
	C.V. (%)		64.6	35.8
Test 2				
Lot #2	Lesan 70W (125 g)	38.9 c	23.4 a	12.9 b
	BTS 40-542 40EC (163 ml)	0 a	14.1 a	7.4 a
	Lesan 70W + BTS 40-542 40EC (62.5 g + 81.5 ml)	27.8 b	18.2 a	9.9 a
	Untreated control	31.1 bc	13.3 a	7.8 a
	C.V. (%)	43.3	65.8	48.3

1/ Mean of 10 plates with 9 seeds/plate.

2/ Mean of 12 plots. Values followed by same letter do not differ significantly at the 5% level according to the LSD test.

B) Rhizoctonia root rot - Plots of commercial sugarbeet cultivar, US H20, each comprising one 7-m row, were planted 22 May with rows 71 cm apart. On 23 July, dried maize kernel inoculum of Rhizoctonia solani was mechanically applied vertically along the plant rows and into the crowns. Fungicides were applied on 15 July and 25 August as aqueous sprays or as granules in a 20-cm row band along the rows and into the crowns. Plots were sprinkler-irrigated lightly on 23 and 24 July. For the remainder of the season, soil moisture was more than adequate. Disease incidence and severity were determined for each plot on 29 September.

Throughout the season, there was little evidence of typical aboveground symptoms of root rot. When the roots were harvested, however, they showed ample evidence of infection with the untreated control having 42% root rot. Treatments that reduced root rot significantly below that of the control were Bayleton 50W (11.2 g/km of row) and Bayleton 5G (224 g) [triadimefon].

C) Phoma betae seed infection - Fungicide seed treatments were applied in acetone solvent to seed of sugarbeet cultivar US H20, heavily infested with P. betae. Fungicide-acetone suspensions were prepared by adding 1.4 x amount of active ingredient needed/g of seed to each ml of acetone. Seed lots (3 g) were soaked in 20 ml of the fungicide-solvent suspension for 90 minutes, then dried on filter paper. To determine degree of Phoma infestation and germinability of seed after treatment, 90-seed samples were plated out on water agar after 5 minute surface-disinfection in 0.5% calcium hypochlorite. To determine efficacy of the treatments in reducing seedling blight under controlled conditions, seeds were grown in boxes of sterile sand in the laboratory for 10 days, after which seedling emergence and pct. seedling blight were determined. Two groups of treatments were tested. The first group comprised 15 single treatments. The second group comprised 5 fungicides, each combined with Lesan 70W - a fungicide that has been extensively used in this area to control seedling blight caused by soil-borne pathogens.

Most of the treatments in both groups reduced Phoma infection of the seed and seedling blight significantly below that of the untreated control. Acetone alone caused a significant reduction in Phoma seed infection but not in seedling blight. Outstanding treatments: Arasan 50W (thiram), BTS 40-542 40EC (prochloraz), and Orthocide 80W (captan) treatments were also highly effective when combined with Lesan (fenaminosulf). There was a high degree of correlation between percent Phoma in seed and in percent seedling blight ($r = .86^{**}$). There were four treatments that resulted in seed germination significantly below that of the untreated controls.

The results indicate that there was no advantage, in most cases, in using the acetone solvent instead of aqueous slurry with the fungicide dusts or coating directly with the liquid treatments, which in previous tests have produced results similar to those obtained with the acetone. Comparisons of Arasan and Orthocide with and without acetone treatment are currently under investigation.

D) Tests with fungal antagonists to control Rhizoctonia root rot - Nine granule cultures and 2 spore-flour cultures were tested with Rhizoctonia-susceptible cultivar, US H20. Plots comprised one row, 7-m long. Each antagonist was tested with one application (15 July) and with two applications (15 and 23 July). Granules were applied in a 20-cm band along the plant row and into the plant crowns. Spore flours were applied in 500 ml water/plot with a watering can. On 23 July, dried grain inoculum of R. solani was mechanically applied along the rows and into the crowns. Immediately after the antagonists and inoculum were applied, a light covering of loose, dry soil was applied into the crowns with a hand-hoe, simulating the cultivation practice of throwing soil into the plant rows with a rapidly moving cultivator blade. Immediately after inoculation, and on the following day, plots were sprinkler-irrigated. For the remainder of the season, the plots remained moist to wet because of frequent rains. On 24 September, plants were dug up and graded according to root rot severity.

Results

One treatment, Corticium sp., resulted in significantly lower disease level compared to untreated control. The number of applications did not significantly affect results. None of the other treatments had any significant effect on disease.

ABSTRACTS OF PAPERS PUBLISHED IN 1980

1) Schneider, C. L., R. L. Sims, and H. S. Potter. 1980. Report of tests of fungicides to control Cercospora leaf spot and Rhizoctonia root rot diseases of sugarbeet, 1978. In Fungicide and Nematicide Tests 35:61-62.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland is directed mainly toward varietal improvement of sugarbeets resistant to Aphanomyces black root and Cercospora leaf spot, important diseases in eastern United States.

Testing for Leaf Spot Resistance

Climatic conditions at Beltsville in 1980 were favorable for the development of Cercospora leaf spot in the sugarbeet nursery creating the most severe epidemic of the last 25 years. Even our most resistant breeding lines had a few blighted leaves by August 14. USH20 was given some poor ratings of 6 and 7 at this date. Unselected fodder beet lines were severely blighted by July 28. Leaf spot ratings on fodder beets were discontinued after July 28 because most lines appearing to have some tolerance became almost as severely diseased as the more susceptible lines. Results of the leaf spot nursery test are presented in Table 1.

TABLE 1. Results of leaf spot tests at Beltsville in 1980.

Description	No. Lines Tested	Date of Rating	Av. Leaf Spot Rating*		
			Breeding Lines	USH20 Check	Resistant Check
Black Root & Leaf Spot Resistant MM lines from Beltsville	74	8/14	4.6	5.9	3.3
MM lines from East Lansing	62	8/14	5.0	6.4	3.5
mm lines from East Lansing	82	8/14	4.3	5.5	3.4
"Soil-free" MM lines from Beltsville (late planting)	33	8/21	4.3	6.0	4.0
Fodder beet lines	68	7/28	5.4	4.0	2.7

* 0 = No spots; 10 = All leaves dead.

The extreme susceptibility of most fodder beet lines is indicated by the poor average rating of 5.4 on July 28, while USH20 had a rating of 4.0 on this date; and the resistant check, a good rating of only 2.7. The extremely severe epidemic at Beltsville in 1980 points out the fact that even after 50 years of breeding efforts we have only succeeded in obtaining enough genetic resistance to leaf spot to have good field tolerance in the

beet growing areas in most years, and that complete immunity, if it is possible, is in the distant future. Heavy selection pressure for resistance is possible, but not feasible because it results in a decline in plant vigor and hence a decline in root yield.

Testing for Black Root Resistance

Tests for resistance to Aphanomyces black root resistance were conducted on more than 500 breeding lines and experimental hybrids. Results of most of these tests are presented in Table 2.

TABLE 2. Results of black root tests at Beltsville in 1979-80.

Description	Number of Lines Tested	Black Root Rating: Av. of lines Tested	Black Root Rating: Resistant Check	Black Root Rating: Susceptible Check
MM progenies from Leaf Spot Selections	142	103	100	111*
MM progenies from Black Root Selections	214	104	100	115**
MM progenies from Powdery Mildew Selections from SP6822-0	61	104	100	113**
MM progenies from Cold Temperature Germination Selections from 6822-0	61	125	100	***

* Minimum-Maximum Possible Ratings = 68-114
** " " " " = 77-130
*** " " " " = 83-138. Susceptible check variety was changed, and wasn't as susceptible as believed to be, hence it is not comparable to other susceptible checks in this table.

Year to year assessment of progress in resistance to Aphanomyces black root is not possible for two reasons: (1) Increases in resistance are small with each selection; and (2) Variability in the severity of infection in the check variety has too big an influence on the apparent resistance of the lines being tested. The first three groups of material in table 2 appear to have good resistance based on the average of their responses to the disease. The cold temperature germination selection progenies, however, appear to be rather susceptible to black root. Part of this numerical higher disease rating can be attributed to the higher minimum-maximum possible score range which is directly related to how severely the check varieties are infected. However, the conclusion is inescapable that this group of progenies is rather susceptible. This is hard to understand because their ancestry traces back to SP6822-0. It is true that they haven't had a selection for resistance for the last six

generations and that selection has been for rapid germination at cold temperatures, but such a rapid loss of black root resistance shouldn't have occurred. One possible explanation is outcrossing to a black root susceptible line that happened to contain good genetic factors for germination at cold temperatures. The opportunity for such outcrossing, however, was not very great.

Cold Temperature Germination Selections

Two successive cycles of selection were made from plant progenies whose seedlings emerged relatively rapidly at cold temperatures. Seed from these second-cycle selections was planted in the cold frame on March 10, 1980, along with seed of some of the parent progenies and seed of five lines that germinated well in the 1979 test. The average 8:00 AM soil temperature during the test period at about 1" depth in 1980 was 2.6°C compared to 1.8°C in 1979. The average 4:00 PM soil temperature was 10.3°C compared to 14.5°C in 1979. Five 1978 progenies that germinated well in the 1979 test were included in the 1980 test together with sixty-seven 1979 progenies and six of the parent lines (1977 seed productions) from which they were selected. Results of these tests are summarized in Tables 3 and 4.

TABLE 3. Performance of five sugarbeet progenies present in both the 1979 and 1980 cold temperature germination test.

		Number of seedlings emerged after being planted for							
Seed No.	Testing Year	11 Days	12 Days	13 Days	14 Days	15 Days	16 Days	17 Days	21 Days
78301-12	1979	0	0	2	2	-*	68	80	-
"	1980	0	-	-	0	0	-	0	42
78301-37	1979	0	12	46	55	-	89	87	-
"	1980	0	-	-	0	2	-	24	25
78302-16	1979	0	0	16	33	-	87	86	-
"	1980	0	-	-	0	3	-	24	48
78302-30	1979	0	1	32	48	-	80	77	-
"	1980	0	-	-	0	2	-	9	48
78302-67	1979	0	1	49	64	-	90	88	-
"	1980	0	-	-	4	7	-	21	52
Av. in 1979 Test		0	2.8	29.0	40.4	-	82.8	83.6	-
" " 1980 "		0	-	-	.8	2.8	-	15.6	43.0

* - = No count made on this day.

TABLE 4. Summarization of Beltsville Sugarbeet Cold Temperature Germination Tests in 1980.

Type of Material	Number Seedlings Emerged On							
	11th Day	12th Day	13th Day	14th Day	15th Day	16th Day	17th Day	21st Day
Average of 67 progenies (Seed produced in 1979)	1.4	-	-	9.4	16.3	-	35.8	49.6
Average of 5-1978 progenies listed in table 3.	0	-	-	.8	2.8	-	15.6	43.0
Average of 6 parental lines of 1979 progenies (1977 seed)	.5	-	-	1.0	1.7	-	3.5	13.5

From table 3 we see that seed germinated much more rapidly and better in the 1979 test than in the 1980. This might be attributed to one or both of two causes: (1) The average warmer afternoon soil temperatures in 1979 could have aided seed germination; and (2) the seed was one year older in 1980, and the age of the seed may influence ability to and speed of germination especially at cooler soil temperatures. In table 4 we see that the 1979 seed did, in fact, germinate more rapidly and somewhat better than the 1978 seed, and the 1977 seed germinated quite poorly and slowly. These results could be due to one or both of two causes: (1) The age of the seed; and (2) the inherent ability of the seed to germinate at low temperatures. Data thus far make the age of the seed suspect in having a big influence in an ability of the seed to germinate at cold temperatures, but I haven't yet proved this. It is inconceivable that the 67 progenies (in line 1 of table 4) inherently germinate as much better than their parental lines (in line 3 of table 4) as the test indicates. Thus, it isn't possible from the tests conducted so far to know how much, if any, genetic improvement has been made in ability to germinate at cold soil temperatures. Seed increases are being made in 1981 of breeding material that will test for both the effect of the age of seed on cold temperature germination and the amount of improvement made as the result of selection.

Breeding for "Soil-Free" Sugarbeets

A "soil-free" sugarbeet line, SP8030-0 was released in 1980. This "soil-free" breeding line appeared to have acceptable percent sucrose at Beltsville, Md. 1979 and again in 1980 (table 5). In 1980 our other "soil-free" sugarbeet breeding lines still appear to have sugar percentages below an acceptable level. SP8030-0 is still segregating minor genetic factors affecting the freedom-from-adhering-soil characteristic, but the worst of these segregates has much less adhering soil than USH20, and the best segregates have essentially no adhering soil under halfway reasonable soil conditions.

TABLE 5. Sugar percentage of "soil-free" sugarbeets in 1980 nursery test at Beltsville, Md.

	Tested Progenies			Check Variety	
Type of Material	No. progenies Tested	% Sucrose	% Raw Juice Apparent Purity	% Sucrose	% Raw Juice Apparent Purity
Components of SP8032-0	34	13.9	86.82	13.8	87.23
F1 of "Soil-Free" MM X Sugarbeet MM	9	11.0	86.96	14.0	87.99
F1 of "Soil-Free" MM X Sugarbeet mm	14	11.1	86.52	14.0	87.99
F2 of "Soil-Free" MM X Sugarbeet MM	12	11.6	85.17	14.0	87.99
F2 of Sugarbeet MM X "Soil-Free" MM	1	11.7	82.22	13.8	87.23
F2 of "Soil-Free" MM X Sugarbeet MM	1	12.1	86.00	13.8	87.23

Beta maritima Male-sterile Cytoplasm

S.P. 80320-02 cytoplasmic male-sterile monogerm was released in August 1980. This male-sterile cytoplasm came from *Beta maritima* (see 1975 Sugarbeet Research Report). This new source of male-sterile cytoplasm might be of value should our existing male-sterile cytoplasm exhibit susceptibility to some disease as happened in corn when Texas male-sterile cytoplasm proved to be extremely susceptible to southern blight. As a bonus, the sugarbeet lines derived from *B. maritima* cytoplasm appear to overwinter better and produce more seed than our other sugarbeets. There is the possibility that it will have better specific combining ability because of its different genetic background some of which has undoubtedly been retained in the released variety.

Fodder Beet Testing at Beltsville

Sixty-seven fodder beet lines were tested in the Beltsville nursery for leaf spot resistance. Root weights were taken on 65 of these lines and sugar analyses were run on 252 individual roots selected as potential parents in the program to breed sugarbeets for alcohol production. Results of these tests are presented in table 6.

TABLE 6. Data on fodder beets tested in the 1980 Beltsville leaf spot nursery.

Variety	Beltsville Entry Number	Av. Leaf Spot Rating	No. Rts. Acre	Tons Rts. Acre	No. Rts. Analyzed	lbs. Av. Wt. of Analyzed Rts.	% Sucrose	% Raw Juice Apparent Purity	lbs. Gross Sugar/ Acre
Blanca	D 1	5.7	17,060	16.57	0	-	-	-	-
Yellow Daeno	D 2	6.3	19,600	16.28	0	-	-	-	-
Peramono	D 3	5.0	13,070	26.12	0	-	-	-	-
Peroba	D 4	6.0	22,870	22.32	0	-	-	-	-
Monara	D 5	5.3	24,680	32.16	7	5.4	2.3	43.81	3,473
Rota	D 6	5.7	20,330	21.62	1	4.0	15.4	88.76	6,659
Oscar	D 7	5.3	21,780	25.54	1	6.7	2.6	45.45	3,422
Pajbjerg Korsroe	D 8	6.0	18,510	20.29	4	4.5	3.9	56.12	1,826
Vital Daehnfeldt	D 9	5.3	17,060	10.40	0	-	-	-	-
US H20	D10	4.7	38,480	18.39	24	1.4	12.3	83.73	4,524
Eckdobarres	D11	5.7	19,600	24.12	2	5.3	1.7	31.25	820
Yellow Eckendorf	D12	6.3	25,050	25.74	0	-	-	-	-
Mammoth Red	D13	5.7	20,330	21.34	0	-	-	-	-
Giant Sugar	D14	5.7	25,050	27.39	0	-	-	-	-
Majoral	D15	4.0	21,050	21.96	0	-	-	-	-
Monovert	D16	4.3	23,230	27.03	8	4.8	6.9	72.71	3,730
Rose Beta	D17	4.3	21,780	27.93	4	5.8	3.5	53.85	1,955
Beta Rose Sugar	D18	3.7	14,520	25.30	15	6.6	5.4	66.91	2,732
Babalonai Yellow Cylinder	D19	4.7	25,770	20.24	3	4.8	6.7	72.91	2,712
Monorosa	D20	5.3	30,860	21.71	0	-	-	-	-
Monobomba	D21	5.3	23,600	29.58	2	4.8	3.8	48.72	2,248
Monoblanc	D22	6.0	24,680	18.02	0	-	-	-	-
Monriac	D23	5.0	22,870	25.37	12	4.7	6.0	67.72	3,044
Monosrover	D24	4.7	23,230	22.38	12	4.3	5.8	64.80	2,596
Poly Blanche	D25	5.7	16,340	19.71	0	-	-	-	-
Barhta	D26	5.7	29,040	31.65	0	-	-	-	-
Barsein	D27	4.3	25,050	24.25	8	4.2	6.5	68.93	3,153
Bar 79-1	D28	5.7	18,880	18.64	0	-	-	-	-
Bar 79-2	D29	5.0	21,050	22.54	4	5.1	4.6	63.54	2,107
US H20	D30	4.0	41,750	19.89	0	-	-	-	-
Cimarosa	D31	5.0	20,330	23.01	10	4.4	7.5	74.04	3,452

TABLE 6 (Continued)

Variety	Beltsville Entry Number	Av. Leaf Spot Rating	No. Rts. Acre	Tons Rts. Acre	No. Rts. Analyzed	lbs. Av. Wt. of Analyzed Rts.	% Sucrose	% Raw Juice Apparent Purity	lbs. Gross Sugar/ Acre
Monofix	D32	5.0	18,150	19.29	9	3.7	7.6	75.40	2,932
Kimono	D33	5.3	17,780	16.12	0	-	-	-	-
FC 630 sib	D34	6.0	8,350	8.82	0	-	-	-	-
FC 631 sib	D35	6.3	24,320	7.39	0	-	-	-	-
(US35/2 x Ovana) X misc.	D36	5.7	17,420	13.43	4	2.4	10.4	85.04	2,793
SP 7799-0 LSR ck.	-	2.7	26,140	19.02	24	1.5	11.9	78.70	4,527
Lamono I mm 2x	F 1	6.3	22,510	20.04	0	-	-	-	-
Lamono II mm 2x	F 2	6.7	19,970	19.66	0	-	-	-	-
Labora I mm 3x	F 3	5.0	19,600	25.36	8	4.8	5.0	61.35	2,536
Labora II mm 3x	F 4	5.3	18,510	25.90	7	4.4	4.1	58.49	2,094
I Red Fodder Beet, Italian	F 5	5.7	18,510	19.00	0	-	-	-	-
II White Fodder Beet, Italian	F 6	5.0	18,510	22.61	2	5.9	2.1	40.08	950
III Yellow Fodder Beet, Italian	F 7	6.0	27,590	28.19	0	-	-	-	-
Solanka mm pelleted, German	F 8	6.7	19,970	20.78	0	-	-	-	-
Paramono mm pelleted, German	F 9	5.3	15,960	25.25	0	-	-	-	-
US H20	F10	4.3	31,940	17.15	24	1.5	11.2	79.32	3,842
Monara mm pelleted, German	F11	5.7	23,230	28.50	4	5.4	2.1	41.18	1,197
Peroba mm pelleted, German	F12	6.0	23,960	21.16	0	-	-	-	-
Kyros mm 3x Danish	F13	5.0	29,040	33.61	10	4.0	5.5	69.44	3,697
Hugin mm 3x Danish	F14	5.3	27,950	27.95	5	4.0	6.6	78.29	3,689
Krake mm 2x Danish	F15	5.7	20,690	18.17	1	3.2	5.7	55.34	2,071
Tetraploid N-type Poland	F16	4.7	22,870	18.53	7	3.6	11.1	85.71	4,114
Tetraploid E-type Poland	F17	5.0	14,520	18.91	7	4.8	4.6	57.50	1,740

TABLE 6 (Continued)

Variety	Beltsville Entry Number	Av. Leaf Spot Rating	No. Rts. Acre	Tons Rts. Acre	No. Rts. Analyzed	lbs. Av. Wt. of Analyzed Rts.	% Sucrose	% Raw Juice Apparent Purity	lbs. Gross Sugar/ Acre
Tetraploid E-type Poland	F18	5.7	18,880	16.30	3	3.2	11.2	83.58	3,651
Tetraploid N-type Poland	F19	4.7	18,880	16.75	6	3.2	10.7	81.43	3,585
Tetraploid N-type Poland	F20	4.7	20,330	14.32	7	3.2	12.4	84.41	3,551
Tetraploid N-type Poland, Rose Hypocotyl	F21	5.0	14,520	20.36	6	4.2	5.3	62.57	2,158
Tetraploid mm N-type Poland	F22	4.7	10,890	14.07	6	4.7	3.9	55.16	1,097
Diploid E-type Poland	F23	5.7	20,330	17.61	2	3.9	6.9	66.47	2,430
Diploid N-type Poland	F24	6.0	22,510	24.19	6	3.5	4.0	62.60	1,935
Cyklop AD 2x Poland	F25	4.7	22,140	30.04	12	4.5	3.2	47.55	1,923
Goliat AD 2x Poland	F26	4.3	12,700	19.09	3	5.3	1.8	34.22	687
Gigant AD 2x Poland	F27	5.0	9,440	15.21	4	5.7	3.4	57.05	1,034
Goliat TPW 2x Poland	F28	4.7	10,160	17.35	6	6.1	1.5	29.24	521
Goliat 4x Poland	F29	5.0	7,260	13.70	3	4.9	3.0	47.47	822
US H20	F30	3.7	37,750	22.58	0	-	-	-	-
Syn. Variety M-14128 4x Greece	F31	5.0	9,080	13.41	2	5.3	4.2	56.15	1,126
Kyros	F32	5.0	22,140	26.83	4	5.6	6.1	72.45	3,273
Monovigor	F33	5.7	26,500	31.11	6	4.0	5.5	70.33	3,422
Prototype 3N Rose	F34	6.0	23,960	25.26	2	4.7	7.6	81.02	3,840
Prototype 3N Blanche	F35	5.0	20,690	23.67	6	4.7	6.0	73.26	2,840
Geante Blanche	F36	6.0	27,590	28.42	4	4.3	2.1	36.97	1,194
SP 7799-0 Check	-	2.7	24,320	21.13	24	2.0	12.1	82.65	5,113
Svalog Halvlang	-	6.0	-	-	0	-	-	-	-
Polyaurea	-	5.5	-	-	5	4.2	3.8	50.90	-

Most of the fodder beets in the nursery were quite susceptible to Cercorpora leaf spot as was expected. The last leaf spot rating was made on July 28 when our resistant check was receiving ratings of 2 or 3 and USH20 was receiving ratings of 4 or 5. Six fodder beet lines, however, did exhibit some tolerance: (1) Majoral; (2) Monovert; (3) Rose Beta; (4) Beta Rose Sugar; (5) Barsein; and (6) diploid Goliat AD from Poland. Root yields ranged from 10 to 33 tons per acre, forty-one of the varieties having 20 tons or more. Root yields in 1980 generally were depressed because of the lack of rain from July 1 until late fall. On examining the sucrose percentages and raw juice apparent purities, it becomes evident that the good root yields of the fodder beet were simply the result of increased water content. One can speculate that root yields and sugar percentages would have been much better if there had been no Cercospora leaf spot disease. For example, when the first globe-shaped beets of Mr. Deming were tested at Beltsville, they were extremely susceptible to leaf spot and had sucrose content of 2% to 4%. It is not expected that the sucrose content of fodder beets will improve as rapidly with increased leaf spot resistance as did Mr. Deming's globe-shaped beets. On the other hand if one looks at the sucrose content of individual fodder beets, there is hope. Sucrose analyses of roots with highest sucrose content are presented in table 7.

TABLE 7. Sucrose content of fodder beets with best sucrose percentages.

Variety	Ft. Collin's Number	No. of Roots Analyzed	Rt. Wt. of Root Analyzed	% Sucrose	% Raw Juice Apparent Purity
Rota		1			
			4.0	15.4	88.76
Barsein		8			
			3.6	10.1	83.35
Cimarosa		10			
			3.5	10.7	84.92
			5.4	9.8	85.22
Monofix		9			
			4.0	9.1	86.67
Polish 4n N-type	A80-19	7			
			4.5	10.2	81.93
			5.4	9.5	81.90
			3.6	11.0	86.34
			3.2	11.3	84.45
			2.5	13.9	89.56
			2.3	12.1	90.30
			4.0	9.9	84.11
Polish 4n E-type	A80-21	3			
			3.5	11.8	85.69
			1.8	12.5	85.21
			4.2	9.4	79.32
Polish 4n N-type	A80-22	6			
			4.8	10.6	80.85
			2.6	10.9	85.36
			2.7	11.5	83.94
			2.0	13.4	87.07
Polish 4n N-type	A80-23	7			
			4.8	11.8	85.26
			3.0	12.3	82.77
			2.4	14.8	88.89
			3.0	12.5	84.86
			3.3	12.2	85.49
			1.9	13.7	87.21

The raw juice apparent purities of these roots are for the most part quite good indicating a low content of nonsucrose solubles in the juice. This is, of course, a characteristic that is highly desirable in sugarbeets. It is not improbable that such breeding material has the possibility with intensive selection of increasing root yields considerably without depressing sugar percentage and purities very much. In the future 50 ton yields of 14% sucrose beets are within the realms of possibility. In terms of alcohol production, this is near 1000 gallons per acre.

Development of Tissue Culture Techniques

We are trying to develop a tissue culture technique in order to produce haploid plants from anthers. We are now able to get callus tissue started on most anthers placed in culture, but after a short period, growth ceases and the callus dies. We haven't yet been able to produce the proper medium which will permit these calluses to grow luxuriously.

Selecting beets for resistance to Sclerotium rolfsii

G. E. Coe and Nichole O'Neill

Sclerotium rolfsii inoculum for each screening consisted of moist tall fescue seed and wheat bran (1:1 by volume) incubated at 20C with the fungus until the medium was thoroughly infested. Five-to-six-week-old sugarbeet seedlings grown in clay pots in the greenhouse were inoculated by distributing 5 ml of the inoculum at the soil line around and in contact with each hypocotyl. Plants were incubated at 23C in a chamber equipped with a fogger to maintain 100% RH. Sugarbeets were removed from the chamber and after 4 days evaluated for resistance by determining the number of surviving seedlings and extent of hypocotyl injury. The isolate of S. rolfsii used for screening was selected from 6 isolates varying widely in virulence to sugarbeet. A moderately virulent isolate from Maryland was selected because it allowed the greatest difference in disease reaction between sugarbeet cultivars.

Sclerotium rolfsii (southern blight) inoculations were made on approximately 2500 plants of S.P.7822-0 in seven experiments. Eighty-eight plants selected for tolerance were transplanted to nursery plots in May of 1980. The disease continued in these plants killing all except 15 by harvest time. These 15 have been put in pots in the greenhouse for seed production in the spring of 1981. These progeny will be compared with S.P.7822-0 in Sclerotium rolfsii tolerance tests in 1981.

Selections were also made among plants of SP69626-0. Thirty-two selected plants were transplanted to the 1980 nursery plots. Only two survived and are now in pots in the greenhouse. Thirteen other selected plants of SP69626-0 produced enough seed in the greenhouse for testing in September of 1980. Five of these progenies appeared to be more resistant to southern blight than their parental line; three were about equal in resistance; and five appeared to be less resistant. Since there seemed to be no improvement in tolerance, a closer examination was made of the data. The degree of resistance in this type test was influenced to a certain extent

by the diameter of the hypocotyl, the larger plants exhibiting more tolerance than smaller plants. Because of this confounding influence of hypocotyl size, it is difficult to determine if heritable resistance to the disease has been improved, but the data suggest that slight improvement has been made. As in many other sugarbeet diseases, it may take three or four cycles of selections to demonstrate significant improvement in resistance.